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Have You Written That Story?

The first story entered in the *Railway Mechanical Engineer's* prize story contest is published in this issue. Before the closing date of the competition we hope to receive many more articles. No doubt practically all of our readers have very definite ideas as to the problems the mechanical department is facing. While the actual conditions often cannot be set forth—for various reasons—this story contest gives an opportunity for bringing out the problems and pointing the way to their solution.

Read the story in this issue and then write up some of your own experiences. If the story is published it will be paid for at our regular space rates. In addition the authors of the three best stories will receive prizes of $75, $50 and $25. The use of good English and the literary finish will of course be considered in awarding the prizes, but far more importance will be attached to the ideas brought out, the portrayal of the characters, the reproduction of the railroad atmosphere and the development of the plot. You still have more than two months to send in your contribution, but don't put it off until the last minute. Sit down tonight and see whether you can't write a story that will take one of the prizes.

Hands Off the Draft Appliances

The locomotive front end in its present state of development is a crude affair, designed and regulated as it is on a "rule of thumb" basis. There is probably no other part of the locomotive concerning the operation and adjustment of which so many theories are held, the most creditable of which are founded on a very small amount of fact. The general attitude is that one guess is as good as another and every one, from the fireman up, feels perfectly justified in putting into practice his own ideas whenever opportunity permits. Imperfect as they are, however, there must be some arrangement of the draft appliances on each class of locomotive which, with the least amount of back pressure, will produce a free steaming locomotive. The discovery of this arrangement involves no great difficulty, and when once found there is no reason why it should not apply to every locomotive of the same class.

There are probably few railroads in the country today that have adopted or maintain rigid standards of front-end arrangement. This results in a loss of motive power capacity as well as efficiency. These losses are due to improper adjustments of the draft appliances themselves, such as a restricted opening under the deflector plate, the effects of which are overcome by the use of a nozzle opening small enough to force the locomotive to steam, or defects in other parts of the locomotive, failure from which may be prevented by front-end adjustments.

Unfortunately, within comparatively wide limits other defects may be overcome at the nozzle, but the result is a waste of fuel and the loss of capacity due to excessive back pressure from restricted nozzle area, which has been found in tests conducted by the Fuel Conservation Section to be as great as 10 to 20 per cent in the possible ton-mile per hour output of the locomotive. In this connection, air leaks around outside steam pipes were found to cause an increase in fuel consumption as high as 30 per cent. In such cases, when the remedy is applied at the nozzle, the real difficulty is not corrected; it is merely concealed and permitted to grow as a potential cause of complete failure.

When a standard front-end arrangement has once been established unauthorized changes should not be permitted, and traveling engineers, fuel supervisors and front-end inspectors should all be charged with the duty of reporting immediately any variations from standard which they may discover. When an engine is reported not steaming the real

cause of the difficulty should be located at once and the correct remedy applied. The presumption should always be that the draft appliances never are the cause unless they are found to vary from the standard.

There is no longer any real necessity for providing for adjustments in the front end. If variations from the established standard are to be prohibited the obvious course is to remove as far as possible all temptation to tinker with the draft appliances and the parts should be put in place permanently. This at least will remove the opportunity to change the deflector plates and draft pipes, leaving the nozzle alone, to be taken care of by the adoption and vigorous execution of a policy of "Hands Off."

Testing Refrigerator Cars

There have been notable improvements in the design of refrigerator cars during the past few years and the transportation of perishable products is now receiving more general attention than at any time in the past. For that reason the report of comparative tests of refrigerator cars with two different arrangements of ice receptacles, published in this issue, is of particular interest. In the tests the car equipped with the overhead bunker showed a marked saving in ice consumption and also a lower temperature range throughout the load than the car with end bunkers. It is difficult to determine how much of this saving can be attributed to the overhead ice bunker and how much is due to other differences in the construction of the cars. The insulation in both cases was practically the same, but the Chicago Great Western car was equipped with floor racks, while the Santa Fe car did not have them. There can be no doubt that the free circulation of air resulting from the use of floor racks was largely responsible for the more uniform temperature existing in the Chicago Great Western car, although the location of the ice near the top of the car should prove advantageous in promoting the circulation, particularly when the supply of ice becomes low. Whether a part of the saving in ice is also due to the use of the floor racks can hardly be determined. The data presented in the report is interesting and in view of the decided difference in the results obtained, it is to be hoped that additional comparative tests of end bunkers and overhead bunkers will be conducted with cars which are otherwise identical in construction.

Accidents Due to Washout Plugs

One of the significant facts brought out in the report of the chief inspector of locomotive boilers, an abstract of which appeared in the December issue, is the large increase in the number of accidents caused by arch tube and washout plugs. As compared with the fiscal year 1918, the number has more than doubled, and it is almost 50 per cent greater than the largest number reported during any previous year. The history of this cause of accidents is interesting. Beginning with 1912, when the number of accidents due to plugs was 13, the next two years showed an increase to 20 and 21, respectively, followed by a reduction in 1915 to 16, with practically no change in 1916, and a further material decrease to 8 in 1917. In 1918 there were 14 accidents reported, and during the past year the number was 30.

What conclusions may be drawn from these facts? Probably the only definite conclusion justified by the facts presented is that war conditions have been responsible for the increases in 1918 and 1919—probably by increasing the amount of untrained and inferior labor used for washing out boilers. But that alone is strong evidence of the small margin of safety existing under the best of conditions in the use of these plugs. They must, of necessity, be fitted with threads disproportionately fine by comparison with their diameter, making it always a delicate operation to start the plug in the sheet without crossing the threads. When cross threaded the plugs usually leak. Under such conditions, considerations of safety are largely overbalanced by the pressing necessity for keeping the locomotive in service, and almost invariably an attempt is made to tighten the plug to stop the leak. The only other alternative is to take the engine out of service and cool it down in order that the plug may be removed and properly applied.

It seems evident that there is but one adequate remedy for this class of accidents; that is the elimination of the screwed plug and the substitution of some form of handhold plate to close the arch tube and washout openings in the boiler sheets. The number of accidents due to the failure of these plugs does not place them among the most serious sources of casualties, considering as a whole the years during which the boiler inspection law has been in operation, but the erratic nature of the results from year to year, together with the heavy increase in accidents from this source during the past year are sufficient evidence of the inherent danger involved in the use of the screw plug. The removal of this danger is a matter for the attention of the designer. Let him accept the responsibility.

The Next Step

The communication on how to increase production, which appears on another page, indicates clearly the necessity of improving the morale throughout all departments of the railroad service. The railroads, like the greater number of industrial concerns, have made a serious mistake in the past in not taking more positive steps to acquaint their employees as to the problems, large or small, with which they have been confronted and as to the actual financial condition of the properties.

Railroad employees have consistently demanded better working conditions and higher wages. It is rather strange to find, however, that the labor unions have consistently fought increases of rates and have advocated some very peculiar legislation which would prove most detrimental to the railroads from a financial standpoint and would not give any real advantages to the men. The shippers and the public itself have not gone to any greater extremes in accusing the railroad executives of mismanagement. Investigation of most of these accusations has shown that the wrongdoings, if there were any, occurred many years ago and have been entirely wiped out by improvements to the property which have since been made from earnings; moreover, the conditions under which the roads have operated for a number of years have made anything of this sort impossible. It would seem, therefore, that because of the mutual interests of the men and the managements the men would be glad to co-operate with the railroads in pleading their case before the public.

Is it not true that the managements should adopt far more positive and aggressive methods than they have in the past to acquaint their employees fully with the exact conditions of the properties, financially and otherwise? There is no one way of accomplishing this. If real results are to be obtained all of the officers and foremen, and particularly those who come in direct contact with the men, must unite in conducting a campaign of publicity and education that will place the real facts before the men. This important responsibility up to this time has apparently been overlooked on most roads because those in charge did not realize its importance. Immediate steps should be taken to improve the situation and thereby bring up the entire morale of the service.

The spirit of the letter above referred to should be kept constantly in mind. Improved facilities, better tools and more efficient equipment are all well as far as they go, but the most vital factor in securing greater efficiency or increased production is to improve the morale of the forces.

Why a Fuel Department?

Fuel cost the railroads of the United States approximately $290,000,000 for the year ending June 30, 1914; for the year just closed the expenditure for this item was in excess of $600,000,000. With the fuel bill more than doubled, the number of passenger car miles was practically the same for the two years and the increase in revenue ton miles was not in excess of 40 per cent. Furthermore, the number of revenue tons per train increased from 460 in 1914 to nearly 700 in 1919, a factor exerting a tremendous influence in favor of reduced unit coal consumption. The growing importance of the fuel bill is evident and no railroad can afford not to take effective measures to prevent waste in this expenditure. No doubt, this is generally recognized but the requirements for preventing it are far less generally recognized.

The maximum return from the money spent in the purchase of fuel can only be obtained where there is definite responsibility in some department for the selection, acceptance, storage, distribution and consumption of fuel. A review of the history of the progress of fuel from the mine to the firebox shows that to none of the established departments is the conservation of fuel of more than secondary importance. The selection and purchase of fuel is under the jurisdiction of the purchasing agent, whose interest and responsibility is primarily in securing the best possible price per ton. Whether the quality of the fuel receives adequate attention depends largely on his personality. The storage and distribution of the fuel may be left in the hands of the stores department, the operating department or the mechanical department. Its final use in the firebox is in the hands of the enginemen and firemen with such supervision as the road foreman can give to this matter along with his numerous other duties and assignments. If the fuel is distributed through the purchasing and stores department, the responsibility of these departments ends with the receipt of coal tickets in sufficient amount to effect an approximate bookkeeping balance. With the distribution in the hands of either the operating or mechanical departments, there is much the same opportunity for a shift of responsibility between the coal chute and the firebox because economy in the final use of the fuel is a matter for which neither department alone is responsible.

The main object of the operating department is to get trains over the road, maintaining passenger schedules and keeping the line clear of tonnage and, with the condition of power in the hands of the mechanical department, consideration of economy does not usually go beyond the questions of overtime for crews in appraising the success of this effort. The success of the mechanical department is likely to be measured on the basis of the number of engine failures, little attention being given primarily to obtaining from the locomotives their highest overall efficiency. The road foreman of engines is responsible for the operation of the locomotives; he is also responsible for many matters pertaining to the operating rules and not infrequently is burdened with office duties which leave him little time for the consideration of the locomotive beyond cases of actual failure. None of these departments is responsible for fuel conservation and none is aware of the constant waste which may be taking place daily through the divided and easily shifted responsibility.

The only solution of this problem is the centralization of fuel control in a staff department, the primary purpose of which is to find the leaks and initiate proper practices to stop them.

Much has been done by the Fuel Conservation Section of the Railroad Administration in demonstrating the correctness of the principle of organized fuel control. As compared with 1918, during the past year, on the basis of unit consumption, a saving approaching $40,000,000 has been effected by measures almost entirely within the control of the managements of the railroads of the United States. This is partially the result of the organization of fuel departments on a number of roads not previously having them and partly due to the efforts inspired by the Fuel Conservation Section.

The results from the latter cause are only temporary. If the work of the Fuel Conservation Section is allowed to lapse with the return of the railroads to private operation, there will be a reaction from the inspired effort put forth during the war. Interest in the matter will be lost and wasteful practices in the handling and use of fuel so common before the war, will re-establish themselves. Inspiration is of value only so long as it lasts; continued results can be obtained only where definite responsibility exists.

It seems evident, therefore, that failure to continue the work of the Fuel Conservation Section beyond the term of federal control will result inevitably in the loss of much of the ground which has been gained in the general establishment of correct practices in the handling and use of fuel. The centralized control of fuel conservation measures should be continued through the reactionary period, during which time the summary of locomotive fuel performance compiled and published quarterly by the section should prove of inestimable value in keeping up the interest in fuel conservation measures, as well as in providing concrete evidence of the large return which each road may obtain by the permanent establishment of its own fuel department.

NEW BOOKS

Proceedings of the International Railway General Foremen's Association. 162 pages, 6 in. by 9 in., illustrated, bound in leather. Published by the association, William Hall, secretary, Winona, Minn.

This book contains the proceedings of the International Railway General Foremen's Association convention, held September 2-5, 1919, in the Hotel Sherman, at Chicago, Ill. The addresses delivered before the convention by R. H. Aishton, regional director of the Northwestern region, and L. A. North, president of the association, are given in full. The various papers read before the convention and the discussions of the subjects by the members are recorded and should prove to be a very valuable reference for the members at large. Among the papers read and discussed were several touching on the subject of safety first, by L. A. North, B. F. Harris and W. T. Gale. Other subjects considered were welding of locomotive cylinders, autogenous welding of locomotive parts and several papers on the design and maintenance of draft gear.

Proceedings of the American Railroad Association, Section III—Mechanical. 668 pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the association, 75 Church street, New York.

This volume contains the proceedings of the American Railroad Association, Section III—Mechanical, and covers all of the matters formerly treated separately in the proceedings of the Master Car Builders' Association and the American Railway Master Mechanics' Association. Complete reports are given of the various addresses delivered at the convention by men prominent in railroad affairs, and also the reports of the numerous committees and the discussions by the members. Of particular interest are the papers relating to fuel economy, mechanical stokers, powdered fuel and welding in its various phases, as applied to both the car and locomotive fields. The book was compiled and published by the secretary of the association, V. R. Hawthorne, and covers in the usual complete manner the proceedings of the organization. As in 1918, the standard drawings are issued separately in loose-leaf form.

COMMUNICATIONS

A CORRECTION

Allston, Mass.

To the Editor:

I wish to call attention to an error in the letter "Inadequate Main Driving Boxes," published in the November issue on page 630. The second line in the second paragraph should read: "that where they do hold the box as regards wedge adjustment." It was not my intention to find fault with spring adjusted wedges from the point of view that they do not do the work they were constructed to do in that respect. From my observation they do hold the wedge in adjustment. John C. Murdock.

DANGERS IN EMPTYING BARREL

La Crosse, Wisconsin.

To the Editor:

In reading the October issue of the *Railway Mechanical Engineer* I noticed the device on page 600 for removing liquids from barrels or other containers. I had one of these connections made about six years ago and have discontinued using it because it proved to be unsafe. A helper was emptying a tank of crude oil and the pressure became excessive and blew the head out of the barrel. This might have caused a very serious accident had the helper been standing in front of the barrel, for the entire head was blown about 40 feet.

I think this may be remedied by using some kind of a safety valve connection, but otherwise the oil is liable to get stopped up and raise the pressure of the tank. I had a ¾ in. pipe for the oil outlet and ¼ in. pipe for the air. All connections were identical with those shown in your sketch.

E. Wagner.

HOW TO INCREASE PRODUCTION

South Orange, N. J.

To the Editor:

Because I have always taken a keen interest in studying human nature, I firmly believe that many of the problems that confront us today could be solved if men in all walks of life would study the characters of the men who are associated with them, not only those in authority over them, but those who work under them. Apply this to the questions asked in the November issue of the *Railway Mechanical Engineer*, "What might be done to improve supervision, to put production on a better basis or take the kinks out of the organization?"

There has been such an upheaval in the management of the railroads during the past two years—old methods discarded and new methods adopted; customs (that had been in vogue so long they were considered essential to the well-being and maintenance of the road) swept aside and a complete reversal of the order of the day—that it would be a waste of time to attempt to draw comparisons between the former and the present methods, in an effort to prove which is the most effective.

Something can be done that will improve supervision, increase production, take out the so-called kinks and put every railroad in this country on a strong, healthy financial basis. It may not be accomplished in a month or a year, because confidence has been almost destroyed, because loyalty is almost a forgotten quantity, because incentive no longer exists, because not only the present methods used, but in a measure the former as well, lose sight of, or rather fail to take into account the one big factor that more than any other affects the growth and success of all organizations, namely, morale.

Every official, every man in a supervisory capacity, every employee must be made to feel that the success or failure of the road is largely dependent on his own individual effort. Create this spirit and you will restore confidence, beget loyalty and incentive, will again inspire new life.

No matter what station in life is yours, if you want success you must be absolutely just in your treatment of those associated with you. Be a big man, play the game fair, be big enough to lay aside petty jealous feelings and selfish motives; when matters arise that affect the interest of others, take them into your confidence and your councils. Bend every energy to produce and promote and the wheels of progress that seem almost to have stopped will revolve again.

Let's start. H. L. Jackson.

THE COLLEGE MAN IN RAILROAD WORK

Urbana, Illinois

To the Editor:

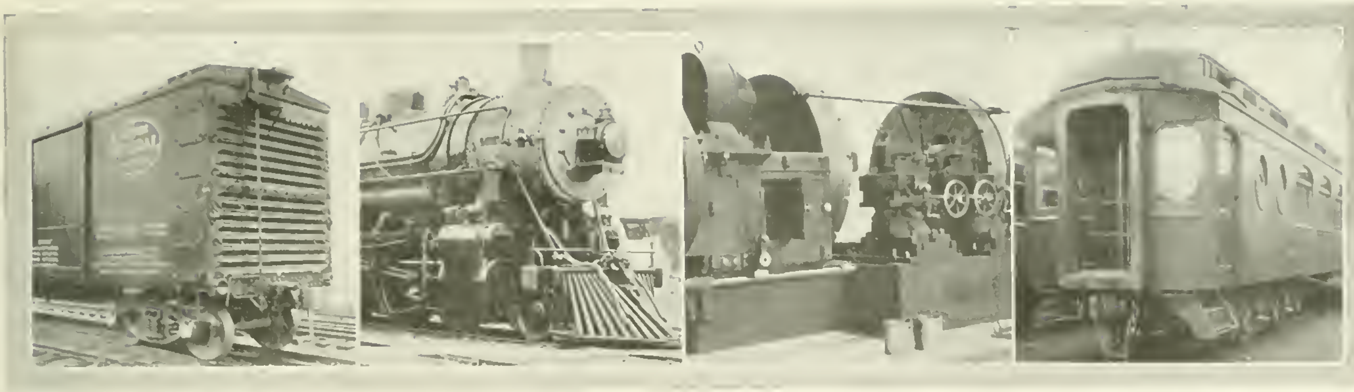
From time to time you have published for the benefit of your readers discussions as to the work of the college man in a railway shop organization. Opinions have differed as to just what consideration, if any, should be made for the four years' training he has received in college, but no one heretofore has attempted to bar him from the shop entirely or to claim that the railroads would be better off without any college men whatever.

But many of us are wondering how a college graduate is going to get into a railway shop or to acquire the practical experience necessary for him to be able to use this training, provided the terms of the present shop agreement remain in effect.

As a helper, the only position the majority may enter, he can receive no training or experience. His services in an official capacity would be of no value without practical experience. By the time he completes his college course he is generally too old for a regular apprenticeship and generally in debt financially. If one of the few to complete college before passing the maximum age at which regular apprentices may be employed, even if financially able, and possessing sufficient determination to go through the regular grind for another full four-year course, he must serve the greater part of this at a rate of pay less than is paid common laborers.

Upon finishing the full apprenticeship course, and having thus spent eight years in preparation for his life work, he would then, according to the present national shop agreement, be entitled to only the poorest and least desirable job in the shop. He would have less seniority rights than the most ignorant or least ambitious boomer who might have entered the shop the day before the college man completed his apprenticeship, the eighth year of his training. Though the latter might not know an indicator card from a dress pattern, or have no conception of the use to which the job assigned him is to be put, no knowledge of the reason for its design or construction, or of the importance of its being finished accurately or with dispatch, he would have preference in the selection of any job in the shop over this man whose four years of college training had been supplemented by an equal period of practical experience in the very shop where he had already worked practically four years before the boomer happened to light. Would anyone call this a square deal? Or does it offer sufficient inducement to the young man desiring to fit himself for railroad work to enter college to better prepare himself for such work?

We do not know whether the situation in which the college man is thus placed was brought about intentionally or otherwise. But if education means anything at all, if there is any place whatever for the college man in a railway shop organization, some provision must be made to give him the opportunity denied him under the present national shop agreement. "The College Man."



RAILROADS' MECHANICAL FACILITIES INADEQUATE

Growing Traffic Cannot Be Handled Without Additional Equipment, Estimate of Needs for Next Three Years

Six billion dollars is the amount that should be spent in the next three years to provide facilities which the railroads will require to handle properly the growing traffic of this country, according to the estimate of the Railway Age. Of this amount nearly $2,000,000,000 should be spent for freight cars, $600,000,000 for passenger cars, $900,000,000 for locomotives, and $150,000,000 for shop and enginehouse equipment.

OTHER FACILITIES

In addition to the rolling stock and shop equipment needed, the Railway Age estimates that the roads should acquire within the next three years 6,000 miles of new tracks at a cost of $600,000,000; revisions of grades, cut-offs and the elimination of curvature, costing $600,000,000; 15,000 miles of new multiple main tracks at a cost of $1,250,000,000; new station buildings costing $300,000, and 10,850 miles of automatic block signals costing $52,000,000.

FREIGHT CARS

There has been serious shortage of freight cars since 1916, except for a few months after the signing of the armistice. The traffic during the last four years has been very heavy, but at present is not greatly in excess of what might be expected under ordinary conditions. The normal traffic for the next six years has been estimated as follows:

	Ton-miles
1920	378,075,000,000
1921	393,815,000,000
1922	410,125,000,000
1923	427,030,000,000
1924	444,540,000,000
1925	462,700,000,000
1926	481,515,000,000

It is probable, however, that the traffic will remain abnormally high for some time to come, and it is estimated that the actual traffic in 1920 will be 410,000,000,000 ton-miles; in 1921, 418,000,000,000 ton-miles, and in 1912, 427,000,000,000 ton-miles.

In order to determine how many cars would be required to move this traffic, a study of the number of ton-miles carried per year for each ton of car capacity was made. This showed that the ton-miles per ton of capacity per year has been in excess of 3,500 for the yearly period whenever there has been a car shortage, and has been below 3,500 whenever was an ample supply of cars. This indicates that one ton of freight car capacity should be provided for every 3,500 tons to be moved during the year. This was actually the case from 1905 to 1915, but the number of cars built in recent years has been abnormally small, and since 1914 there has not been a single year when the railroads have bought enough new cars to take care of the normal increase in traffic.

The Class I roads in 1918 had 2,323,324 freight cars, with an aggregate capacity of approximately 97,000,000 tons. The increase in capacity during 1919 has probably not been more than 1,500,000 tons, making the present capacity 98,500,000 tons. As Class II and Class III roads own about 2.7 per cent of all railroad freight cars, this capacity must be increased by that amount to make it comparable with the statistics of traffic. This would bring the total capacity for all roads to 101,100,000 tons. Under normal conditions this capacity would be sufficient to handle an annual traffic of 354,000,000,000 ton-miles, but since the traffic in 1919 will amount to about 400,000,000,000 ton-miles it is evident that there is not enough equipment to handle it in a satisfactory manner. On the basis of 3,500 ton-miles per ton of capacity per year, the present traffic would require a car capacity of 114,200,000 tons, or about 13,100,000 tons more than is now available. As the average capacity of cars now built is 50 tons, this would indicate that 262,000 additional cars must be provided to make up for the present shortage.

Assuming that business will increase at a constant rate and will reach the normal in 1924, the annual increase will amount to 8,108,000,000 ton-miles, which would require a capacity of 2,320,000 tons. Assuming that the average capacity of the cars built will increase to 55 tons, this would require 42,000 cars. This is not representative of the number that would ordinarily be needed to care for the increase in the traffic, because the present traffic is high, and therefore the assumed rate of increase for the next three years has been made correspondingly low. Under normal conditions about 100,000 cars would be needed to provide for the increase in traffic.

Aside from the question of providing for the traffic, there remains the need for retiring old equipment from service. As the demand for freight cars has been greater than the supply for more than three years, cars have been kept in service whenever it was possible and the number retired has been very low. Statistics indicate that the retirement of 120,000 cars which would naturally have been scrapped during the past three years has been deferred. The Railroad Administration has stated that of the 150,133 cars bad order on the fifteenth of November 19,300 were held out of service as not worth repairing. This is certainly a minimum figure. The deferred retirements amount to at least 100,000 cars, and although some of the box cars may be worth reinforcing

and returning to service, not less than 75,000 cars should be scrapped.

The report of the Interstate Commerce Commission for December 31, 1917, showed that at that time the Class 1 carriers still had in service 904,007 freight cars not of all-steel or steel underframe construction. Until these light wooden cars have been scrapped the rate of retirement should certainly not be less than 120,000 cars per year. Assuming that 25 per cent of this equipment can be reinforced, there still remain 90,000 old cars to be destroyed during each of the next three years. The average capacity of the cars scrapped will be approximately 33 tons and the capacity of new cars 50 tons. Therefore, to replace the equipment ton for ton would require:

	Cars
For deferred retirements	49,500
For normal retirements ... per year	58,300

SUMMARY

Summing up the cars needed to make up deficiencies, to provide for future increases and to take care of retirements, the total amount of equipment required during the next three years is found to be as follows:

	Cars
To make up the present shortage	262,000
To provide an adequate surplus	100,000
To take care of increases in traffic	126,000
To make up for deferred retirement	49,500
To care for normal retirements	174,900
Total cars needed in three years	712,400
Annual requirements	237,500

The private car lines own about 200,000 freight cars and the Canadian roads have also about 200,000. If the new equipment needed by these car owners bears the same relation to the total number owned that prevails for the railroads in the United States, the car-building plants of this country and Canada should be called upon to furnish 830,000 cars during the next three years.

TYPE OF CARS THAT WILL BE BUILT

Few important innovations in freight car design have been introduced in the past decade, and the equipment built during the next few years will probably not be radically different from the types now in service. Box cars form a large percentage of the equipment and little further increase in capacity is to be expected, as the opinion seems to prevail that nothing is gained by increasing the capacity of box cars above 40 tons. In open-top equipment, however, there is a strong tendency toward the use of high-capacity units. Ninety-ton cars are by no means uncommon, and experimental cars of 105 and 110 tons' capacity have been constructed. The operating results secured with high-capacity cars have been satisfactory, and they will probably be built in greater numbers.

The unit cost of the equipment which the railroads buy in 1920 will be greatly in excess of pre-war prices. The lowest scale of prices for freight cars in recent years was that prevailing in 1914 and 1915. At that time cars could be bought for $800 to $900. By 1916 they had advanced to $1,100, in 1917 to $2,100 and in 1918 the average was about $2,850. The prices that will prevail during 1920 will depend on the cost of materials, and cannot be predicted with any degree of certainty. Under present conditions practically the same prices that existed in 1918 apply. It is probable that the 240,000 cars that should be built this year would cost between $670,000,000 and $700,000,000. Assuming that present prices continue the 712,000 cars needed in the next three years will involve an expenditure of approximately $2,000,-000,000.

PASSENGER CARS

The shortage of passenger equipment at the present time is brought out strikingly by the fact that in 1919 the number of passengers per car was 31 per cent greater than the maximum during any year from 1905 to 1915. In the 10-year period ending June 30, 1915, the volume of passenger traffic on the railroads of the United States, as measured by the number of passengers carried one mile, increased 48 per cent. During this period 26,800 passenger train cars were purchased.

In the four and one-half years since June 30, 1915, the number of passengers carried one mile has increased over 43 per cent, but less than 4,000 cars have been purchased. To provide for the present volume of passenger traffic on pre-war standards of service, without allowance for retirements, would require over 18,000 more passenger train cars than the railroads now own.

During the ten calendar years ending with 1914, the Railway Age reports a total number of passenger cars ordered of approximately 22,900, of which 78 per cent were for the steam railroads of the United States. During the same period Railway Age statistics show a total of approximately 34,400 passenger cars actually built in the United States and Canada. While it is evident that the statistics for the number of cars ordered is not as complete as for the number of cars built, it is reasonable to assume that approximately the same proportion in each case were for use on the steam railroads of the United States. On this basis it is evident that the railroads must have received about 26,870 new passenger train cars during the ten years from 1905 to 1915. But during this time the actual number of cars in service increased only 14,063, and it is evident that about 12,800 cars must have been retired. The yearly average for the ten years is, therefore, 2,687 new cars purchased, of which 1,280 replaced old cars retired from service and 1,406 were added to take care of the traffic increase.

During the four and one-half years since June 30, 1915, passenger miles have increased 13,810,000,000, or 43.5 per cent. This is a larger proportionate increase than that for the ten years prior to 1915 and but slightly less than the actual maximum increase during the period from 1905 to 1914.

During the first year and one-half of this period there was actually less passenger equipment in service than at the beginning of the period, and at the end of 1917 there were only about 300 more passenger cars in service than were shown for the fiscal year 1915. For the whole period of four and one-half years, with its increase in volume of passenger business of over 43 per cent, the number of passenger cars in service increased by 2.5 per cent.

While the number of cars ordered during the four calendar years ending with 1918 was approximately 7,000, only 45 per cent of this number were for use on the steam railroads of the United States. Applying the same percentage to the approximately 7,490 cars built during the four and one-half years prior to December 31, 1919, only 3,370 passenger train cars were built for steam railroad use in the United States. As at least half of the cars built in 1915, or about 440, were probably in service prior to July 1, the beginning of the period under discussion, the number of new cars actually placed in service in the four and one-half years probably did not exceed 2,930. As the number of passenger cars in service increased but 1,310 during the period, it is evident that about 1,620 cars were retired. An average of only 652 new cars were received by the roads annually, of which 360 were replacements and 291 were additions to the passenger carrying equipment of the country.

Comparing the years up to 1918, there is evident a growing inability of the equipment available to meet the heavy increase in traffic, which is shown by the increase in the number of miles per passenger carrying car per year from 59,600 in 1915 to 66,000 in 1917, with a corresponding in-

crease in the number of passengers per car from 15.3 in 1915 to 17.6 in 1917.

In 1918 there was a sharp decrease in car mileage, due to the curtailment of service effected by the Railroad Administration. This and an increase in the number of cars in service of 961 resulted in lowering the average car miles per passenger carrying car from 66,000 to 58,600, but the number of passengers per car increased from 17.6 to 20.4, by far the largest increase ever recorded. Of course, the heavy troop movement, which was practically continuous throughout the year 1918, tended to increase this figure above that representing conditions prevailing in the handling of regular passenger business. The aggregate of this troop movement for the 22 months from January 1, 1918, to November 1, 1919, however, was 5,917,658,719 passenger miles, or only 14 per cent of the total volume of passenger business of the year 1918 alone, and can hardly have exercised a predominating influence on the average. Its effect may practically be eliminated by comparing 1917 with 1919, as the troop movement during these two years was confined to about one-half of the year in each case, and here the increase is shown to have been over three passengers per car.

The sharp decline in passenger car mileage, showing an average of 58,600 and 61,400 miles per car per year, respectively, for 1918 and 1919 following the high mileage during 1917, raises the question as to whether the change in conditions is actually due to a shortage of equipment or entirely to the war policy of the Railroad Administration. Assuming, however, that the equipment had been used to the same extent during these two years as it was during 1917, so that each passenger carrying car had averaged 66 000 miles for the year, the number of passengers per car would have increased to 18.1 in 1918 and 19.3 in 1919, clearly demonstrating that even under normal methods of handling passenger business there would still have been a rapidly growing shortage of equipment.

Passenger equipment may be divided roughly into two major classes: (1) passenger carrying cars and (2) express, baggage and postal cars. In the tables already referred to are given a clear presentation of the volume of passenger traffic and the total number of passenger carrying car miles to handle the traffic. This forms a fair basis for determining the needs for passenger carrying cars if the assumption is made that there has been no great change in the relative amount of car mileage made by equipment of railroad ownership and Pullman sleeping and parlor cars, or that there has been no material increase in the carrying capacity of passenger cars of railroad ownership. The remarkable uniformity of the number of passengers per car during the eight years prior to June 30, 1915, would indicate that these are reasonable assumptions. At the end of that period there were 10,884 passenger train cars of all-steel construction and 5,197 with steel underframes, a total in both groups of 38 per cent of the equipment in service, practically all of which had been built during that period, with no marked effect on the average car load.

Leaving out of consideration the first three years of the ten years prior to 1915, during the first two of which the number of passenger-miles per passenger carrying car was light, and considering only those years for which passenger car mileage statistics are available, it will be found that the average number of passenger-miles per passenger carrying car average about 950,000, which was equivalent to an average of about 61,500 miles per car per year with an average load of 15.4 passengers per car. To have handled the 45,000,000,000 passenger miles of passenger traffic in 1919 under these same conditions would have required a total of 48,000 passenger carrying cars, but there were only approximately 35,700 passenger carrying cars in service during that year, indicating a shortage of 12,300 cars.

But it is questionable whether passenger service should ever be restored completely to the competitive basis existing prior to 1915. It will be conservative to assume that the service should be restored to the standards of 1917, when there were 17.6 passengers carried per car movement, and it would seem reasonable to expect the maintenance of an average mileage per car throughout the country of 63,000 per year. To have handled the 45,600,000,000 passengers carried one mile in 1919 on this basis would have required 41,080 cars, which is 5,480 cars more than were actually in service.

Assuming for the next three years an annual increase of an even 2,000,000,000 passenger-miles, the railroads will be required to purchase 5,400 additional passenger carrying cars during the three-year period to maintain the standards of service and equipment mileage outlined above. It will, therefore, be necessary to purchase 10,880 passenger carrying cars during the next three years.

During 1918 the passenger carrying cars of the Class I railroads made up 66 per cent of the total number of passenger train cars in service. Assuming the continuance of this ratio, which, however, has been gradually decreasing, it will be necessary to purchase 5,620 new baggage, mail, express, dining and other passenger train cars in addition to the passenger carrying cars, which include coaches, combination passenger cars and sleeping and parlor cars of railroad ownership. Of this number about 4,800 will be baggage, mail and express cars.

During the ten years prior to 1915 there was an average retirement of 1,280 cars annually. During the last four years there has only been retired an average of 360 cars each year. It is evident, therefore, that there are 4,140 cars now in service which should be retired at the earliest opportunity, and on the same basis 3,840 more cars should be retired during the next three years. Adding these 7,980 cars to the actual increase required, it is evident that there must be purchased during the next three years a total of about 24,500 passenger train cars, or an average of 8,160 cars a year, if passenger service is to be restored to the 1917 standards.

Such data as is available indicates that the increase in prices of passenger cars which has taken place during the war period has been about 200 per cent, or in other words, that the equipment purchased now will cost approximately three times as much as the cost of similar equipment purchased in 1914. This ratio holds very closely true when applied to the prices for locomotives and freight cars paid by the Railroad Administration during 1918, and, considering the increases in prices which have taken place since, it may be considered a conservative basis on which to estimate the capital required for the purchase of new equipment. Baggage, mail and express cars costing between $6,000 and $7,000 in 1914 will cost on an average of $21,000 to $22,000 at the present time, while steel coaches which cost $8,500 in 1914 can probably not be built at the present time for less than $25,000 to $26,000. Applying these prices on a weighted average basis of the proportion of these two classes of equipment to the total, a conservative price for the 24,500 cars required in the next three years may be taken at $24,000 each.

If the railroads are to restore and maintain passenger service to the standard of 1917, an expenditure, therefore, of $588,000,000 will be required for new equipment during that time; this is an annual average of $196,000,000.

LOCOMOTIVES.

The motive power situation is fully as serious as the shortage of freight and passenger cars. A conservative estimate, based on the average increase in railroad traffic and in the motive power during the decade ending with the year 1914, indicates that at least 698,000,000 lb. additional tractive power should be built in the next three years.

During the period from 1905 to 1915, in addition to an

increase of 34 per cent in the number of locomotives on American railroads, there also was an increase of 71 per cent in the aggregate tractive power. Statistics of the Interstate Commerce Commission show that the average distribution of tractive power is 63.5 per cent in freight service, 20.5 per cent in passenger service, 14 per cent in switching service and two per cent unclassified. The estimates of future requirements are based on these ratios, and the small percentage of new unclassified locomotives is included with those for freight service.

In the year 1905 the freight traffic of the United States totaled 186,463,109,510 ton-miles, and this increased at a fairly constant rate until in 1914 it had reached a total of 288,319,890,210 ton-miles, an average yearly increase for the decade of 5.46 per cent. This rate of increase if continued to the end of the year 1919 would have made a total freight traffic of 388 billion ton-miles. However, the statistics of the first ten months of the year 1919 and a conservative estimate of the probable volume of business for the months of November and December indicate that the actual freight business for the year will reach the enormous total of 402 billion ton-miles. These figures for the year 1919 may be taken as a basis on which to estimate the probable freight traffic for the next three years, which will probably reach 410 billion ton-miles in 1920, 418 billion ton-miles in 1921 and the stupendous total of 427 billion ton-miles in 1922.

To handle properly this vast amount of freight in 1920 it will be necessary to have an aggregate tractive power of 1,651,000,000 lb. in freight locomotives. This will require the building of a large amount of additional motive power. New freight locomotives to be built should average about 60,000 lb. tractive effort.

The statistics of the Interstate Commerce Commission show that in the past years approximately 63.5 per cent of the total available tractive power was engaged in freight service, and on that basis 248.3 ton-miles of freight were hauled during the year for each pound of tractive power of freight locomotives. The average ton-miles per year per pound of tractive power was somewhat in excess of 248.3 in 1918 and 1919, but an average taken over the entire period of 14 years from 1905 to 1918 was only 251.1 ton-miles per year per pound of tractive power. This average is subject to fluctuation, and as will be seen in the tabulations the average ton-miles per pound of tractive effort in 1906 reached the extremely high figure of 273 ton-miles, but dropped to 235 ton-miles in 1914. It is for this reason that an average for a ten-year period during normal times is taken as a basis for calculating the work that will probably be done in the future. This average may be improved upon, but there is no certainty that such will be the case.

As already stated, the estimated freight traffic for the year 1920 will be 410 billion ton-miles, and to haul it will require freight locomotives having an aggregate tractive power of 1,651,228,000 lb. On the basis given above, 153,245,000 lb. additional tractive effort would be needed to bring the aggregate for 1919 up to the proper point, and to this amount must be added 32,218,000 lb. necessary to provide for the increase in freight traffic in 1920. The increase in freight traffic to 418 billion ton-miles in 1921 will require an increase of 32,219,000 lb. tractive power, and the increase to 427 billion ton-miles in 1922 an additional 36,246,000 lb. Normal and deferred retirements of freight locomotives during the next three years make it necessary to provide 190,472,000 lb., and the proportional increase in unclassified locomotives an additional 8,091,000 lb., so that it will require an aggregate increase of 452,490,000 lb. tractive power in freight locomotives in three years. This makes a total to be built of 7,542 units of 60,000 lb. average tractive effort. As heavy freight locomotives cost approximately $82,000 in 1918, and it is quite probable that this price will continue, the total cost of freight locomotives required in the next three years will be $618,444,000. This is a yearly average of 2,514 freight locomotives, costing $206,444,000.

PASSENGER LOCOMOTIVES

The passenger traffic of the railroads of the United States during the decade ending with the year 1914 increased 11,458,240,073 passenger-miles, or 48 per cent. During this same period the number of passenger locomotives increased only 25.8 per cent, but as in the case of freight locomotives the average tractive power increased rapidly.

The passenger locomotives in service in the year 1914 were 23 per cent of the total number of locomotives and the aggregate tractive effort amounted to 396,051,000 lb., or 20.5 per cent of the total for all classes. No figures being available as to the actual aggregate tractive effort engaged in passenger traffic in recent years, it may reasonably be assumed that the same ratio that existed in 1914 (20.5 per cent) will apply. On that basis the passenger traffic for the year 1919 would have required 521,669,000 lb. tractive power, but the total available power was only 473,199,000 lb.

The total available tractive effort on December 31, 1918, being 2,196,648,349 lb., and assuming that 20.5 per cent of this amount was engaged in passenger traffic, this additional tractive effort required for passenger service to bring the total for the year 1919 up to normal would be 48,470,000 lb., and with the increase computed on the basis of 20.5 per cent, 11,404,000 lb. are required for 1920, 10,401,000 lb. for 1921 and 11,702,000 lb. for 1922. To replace the normal and deferred retirements of obsolete passenger locomotives 59,613,000 lb. are required, making a total increase of 141,601,000 lb. tractive power required to be built for passenger service in the next three years.

This would require a total of 3,218 units of 44,000 lb. tractive power each, and as the probable cost of passenger locomotives will approximate $60,000 each, it will necessitate a total expenditure of $193,080,000 for this purpose during the next three years.

SWITCHING LOCOMOTIVES

The I. C. C. statistics show that 15.6 per cent of the total number of locomotives in service were switching locomotives, and on the basis of 14 per cent of the aggregate tractive power there were 323,160,000 lb. of tractive power in switching service in the year 1919. Additional power of 33,785,000 lb. tractive effort are required to bring the switching service to its proper proportions, and this amount should be constructed in the year 1920. To meet the normal increase in traffic in 1920 will require 7,105,000 lb., the increase in 1921 will require 7,203,000 lb. and in 1922 it will require 7,891,000 lb. additional tractive power.

Besides these increases, the deferred and regular retirements of switching locomotives to be replaced with modern power will require 40,712,000 lb., making necessary a total increase of 96,696,000 lb. tractive effort in the next three years. Taking 40,000 lb. tractive power as an average for this class of locomotives, this would require 2,417 units, and at an average cost of $40,000 each the total cost of switching locomotives to be built in the next three years would be $96,680,000, or a yearly average of 806 locomotives, at a cost of $32,226,666, which represents the requirements of this class of the service.

SUMMARY

The total increase in the aggregate motive power required in the next three years and the estimated cost is as follows:

Normal increase in lb. tractive power:	
Freight locomotives	261,928,000
Unclassified locomotives	8,099,000
Passenger locomotives	81,988,000
Switching locomotives	55,985,000
Total	408,000,000

Deferred and normal retirements in lb. tractive power:	
Freight locomotives	190,472,000
Passenger locomotives	59,613,000
Switching locomotives	40,712,000
Total	290,797,000
Cost of replacing retirements:	
3,175 freight locomotives	$260,350,000
1,332 passenger locomotives	79,920,000
1,017 switching locomotives	40,680,000
Total	$380,950,000
Cost of retirements when built:	
9,320 freight and unclassified locomotives	$142,400,000
2,760 passenger locomotives	41,700,000
1,920 switching locomotives	21,300,000
Total	$205,400,000

	Tractive power, lb.	Number of locomotives	Cost
Normal increase and retirements	407,999,000	7,653	$527,254,000
Deferred retirements	290,797,000	5,524	380,950,000
Total	698,796,000	13,177	$908,204,000
Average per year for three years	232,599,000	4,392	302,735,000

The cost of locomotives to be retired is taken as equal to the cost in the year 1905, when freight locomotives cost $15,-250, passenger locomotives $15,100 and switching locomotives $11,100. This will retire from service locomotives costing $205,400,000 when built, and the capital expenditures of the railroads for locomotives will therefore be $702,804,000 in the next three years, as shown below:

Total cost of locomotives to be built in three years	$908,204,000
Total cost of locomotives to be retired in three years	205,400,000
Addition to capital expenditures	$702,804,000

The total number of locomotives that should be built in the next three years is 13,177 and the total to be retired is 12,000 locomotives, making an increase of 1,177.

SHOP AND ENGINEHOUSE EQUIPMENT

In attempting to make an estimate as to the amount that railway repair shops are behind in their shop and enginehouse equipment, it will be necessary to know how much has been spent for this purpose in the past few years.

Table I—Statistics for Class I Carriers

For fiscal year ending	Total operating expenses	Account 302 shop machinery	Per cent of total expenses
June 30, 1911	$1,844,065,958	$10,061,423	.546
June 30, 1912	1,898,662,465	10,417,543	.548
June 30, 1913	2,108,947,614	12,182,668	.578
June 30, 1914	2,139,755,988	11,674,904	.546
June 30, 1915	2,021,160,614	8,916,891	.441
June 30, 1916	2,210,892,786	10,295,918	.466
December 31, 1916	2,357,398,412	11,517,657	.489
December 31, 1917	2,829,325,123	14,552,997	.514
December 31, 1918	3,948,132,200	27,520,000	.696
December 31, 1919	4,335,000,000*	30,250,000	.698

*Estimate based on statistics for the first ten months of 1919.

Reference to Table 1 shows that in the fiscal year ending June 30, 1911, $10,661,423 was spent for shop equipment and to repair and replace worn-out shop machinery. There was an increase to $12,182,668 in the following two years, but for the succeeding four years the shop machinery charge was below normal. It was not only small, but a relatively small proportion of the total operating expense. This failure to keep repair shop facilities up to the necessary standard was due, as previously stated, to the difficulty of securing capital, scarcity of labor and the high prices and scarcity of materials. With the beginning of government control in 1918 capital was available, and the priority given to government orders made possible the purchase of railway equipment. Consequently the shop machinery charge practically doubled during the year 1918, as indicated on the chart. This does not mean, however, that twice as much machinery and equipment was repaired and replaced in 1918 as in former years. The fact is that twice as much money was paid for the usual amount of equipment. A canvass of machine tool builders and other manufacturers indicates that 100 per cent is a conservatives estimate of the increase in cost of machine tools and shop supplies since 1916.

The ratio of shop machinery to total operating expense in 1911 was .546 per cent. This ratio increased to .578 per cent in 1913 and then, due to causes before stated, dropped below normal for the succeeding four and a half years. During 1918 and 1919 the ratio increased to .696 and .698 per cent, respectively.

If, however, the ratio is considered constant at .578 per cent during this period, a conservative estimate of the deficiency in shop machinery during this period will be obtained. The difference between .578 and the actual ratio for any one year multiplied by the total operating expense for the corresponding year will give the difference between the amount of money that should have been spent on shop machinery for that year and the amount that was actually spent. These amounts have been calculated, and their sums are shown in Estimate (a) as $9,835,000. However, the statistics given in Table I apply to Class I roads only. The operating expenses of Class I roads are about 96 per cent of the total operating expenses of all carriers, and 4 per cent has been added to $9,835,000, making a total of $10,229,000. But this equipment and machinery should have been bought previous to 1917, and it will now cost 100 per cent more to replace it, which brings the deficiency up to $20,458,000.

Table II -1918 Statistics of Six Representative Roads

Name of road	Total operating expenses	Account 302 shop machinery	Per cent of total expenses
Atchison, Topeka & Santa Fe	$144,912,375	$884,374	.610
Chicago, Burlington & Quincy	112,067,616	997,507	.890
Southern Pacific	113,652,897	738,237	.650
Chicago, Milwaukee & St. Paul	122,196,105	531,558	.434
Pennsylvania (Lines East)	333,624,523	2,886,760	.865
Pennsylvania (Lines West)	86,550,256	632,213	.729
Total	$913,003,772	$6,670,649	4.178
Average per cent			.696

During the years 1918 and 1919 the amount of money spent for shop machinery was greater than the average, but the machinery and equipment actually acquired was probably less than normal, due to the depreciated value of the dollar. The amount of money spent during the same period for additions and betterments to take care of increased business was wholly insufficient. The replacement value of railway shop machinery in the United States is $292,200,000. Inasmuch as the annual increase in equipment has been not less than 3.70 per cent and it will require at least 4.2 per cent increase in shop facilities to handle this equipment, the necessary additions and betterments may be expressed as .042x2x292,200,000=$24,450,000. The total deficiency in shop machinery and equipment up to the present time, therefore, is shown in Estimate (a) as $44,908,000.

Data extending over a four-year period show that only 67 per cent of the shop machinery charge represents material, the balance representing the labor required to repair and replace the worn equipment. Consequently, as shown in Estimate (b), there is $20,250,000 worth of material in the annual shop machinery charge. This must be increased by 4 per cent to include all roads; and in a period of three years the total estimated amount of material to be bought will cost $64,470,000.

That this figure is not excessive may be shown by a consideration of reasonable depreciation charges for the three-year period. It is true that some shop machinery has been used for 20 years or more, but with the continual modern changes and improvements it is doubtful if any machine will have a useful and efficient life greater than 15 years. This means an annual depreciation of 6.67 per cent, which for three years on an investment of $292,200,000 is $58,-500,000. In other words, the estimate of $64,470,000 for shop facilities would hardly do more than cover shop machinery depreciation.

Additions and betterments, being chargeable to capital

account, provide the necessary equipment to care for increased business. In order to estimate future needs, it is necessary to examine past expenditures for this account. In the 30 months from June 30, 1914, to December 31, 1916, only $6,063,719 was spent for shop machinery additions and betterments. During the following year $6,000,000, and in the first year of government control $7,698,596 were spent for machine additions and betterments, but that this amount was entirely inadequate for the needs is indicated by the fact that only 35.2 per cent of the authorized additions and betterments were actually made.

According to estimates made in 1916, the total value of railway shop machinery in the United States amounted to $146,100,000. Referring to Estimate (c), the replacement value of this machinery in 1919 would be at least $292,200,000. Assuming then that the plant must be increased 4.2 per cent per annum to care for the new equipment, the total investment in the next three years must be $36,780,000.

The total amount of money that should be spent during the next three years for shop equipment and machinery, as shown in Estimate (d), is $146,158,000. This amount is probably less than the actual needs. The magnitude of the result gives some indication of how serious the situation has become. The cost of all materials has practically doubled in the past three years, shop employees' hours have been reduced to eight hours and wages have increased on the average at least 100 per cent. To offset these increased costs and place back into service the locomotives now held waiting repairs, it will be necessary to make up previous deficiencies in equipment and modernize all shops.

Automatic and semi-automatic machinery, for example, should be more generally used in back shops where material is manufactured for the whole system. Another field that deserves particular attention is the enginehouse machine shop.

The material and equipment purchased for railway shops and included in this discussion is of almost infinite variety from belts, air hose, rope and packing to boilers, cranes, welding equipment, lathes, etc. The largest single item is machinery and tools. Approximately 38 per cent of the total material costs are for machinery, which means that during the next three years $54,100,000 should be spent for railway shop machinery and machine tools.

The summary given above is exclusive of the structures required for shops and terminals. According to the estimate of the Railway Age, $250,000,000 should be spent on these buildings during the next three years.

ESTIMATE

(a) Deficiency in shop machinery:		
From June 30, 1913 to December 31, 1917—		
.578 — .546 = .032 × $2,139,755,988 =	$685,000	
.578 — .441 = .137 × 2,021,160,614 =	2,770,000	
.578 — .466 = .112 × 2,210,892,786 =	2,475,000	
.578 — .489 = .089 × 2,357,398,412 =	2,095,000	
.578 — .514 = .064 × 2,829,325,123 =	1,810,000	
	$9,835,000	
Adding four per cent to include all roads..	394,000	
Deficiency in shop machinery December 31, 1917	$10,229,000	
Cost of replacing in 1919........	$20,458,000	
Deficiency in additions and betterments to December, 1919	24,450,000	
Total	$44,908,000	$44,908,000
(b) Maintenance of shop machinery (for three years 1920-1922):		
Annual shop machinery charge........	$30,250,000	
But only 67 per cent is material........	20,280,000	
Adding four per cent to include all roads...	1,210,000	
Total material to be purchased annually	$21,490,000	
For three years........	3	
Total	$64,470,000	$64,470,000
(c) Additions and betterments (for three years 1920-1922):		
Value of shop machinery in 1916........	$146,100,000	
Replacement value in 1920........	292,200,000	
Annual equipment increase of 3.7 per cent will require 4.2 per cent investment in machinery	12,260,000	
For three years........	3	
Total	$36,780,000	$36,780,000
(d) Grand total (a) + (b) + (c)........		$146,158,000

THE INCENTIVE FOR HIGHER EFFICIENCY*

BY D. C. BUELL
Director, Railway Educational Bureau, Omaha, Neb.

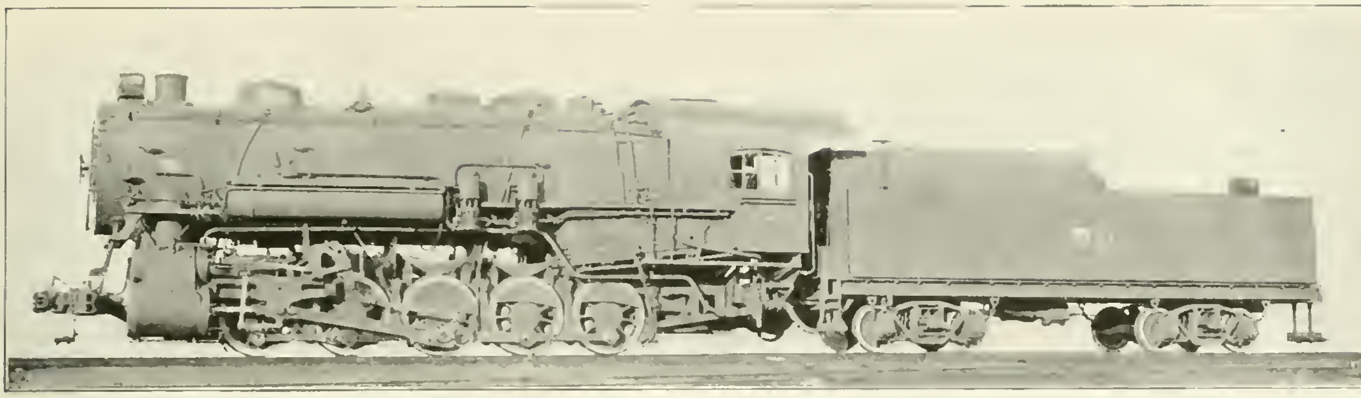
Our ablest statesmen, economists, and financiers, as well as our leading business men are confronted with an industrial problem—perhaps the most serious in the history of our country—the labor unrest which is almost universal. My experience with a small organization of railroad men in France taught me some lessons about this problem. These men in a strange environment, with almost no facilities for efficient work, housed in barracks, eating in the open from their mess kits, performed one of the quickest and most efficient jobs of erection work that I have ever witnessed. The reason for this efficiency was that there was an incentive which caused them to put forth their best efforts to accomplish the task in hand.

Our labor unrest today is largely due to lack of incentive. We do not see the future clearly. You men are in intimate daily contact with a large proportion of the workers employed in the various shop crafts on our American railroads. You must be the leaders in an educational movement that will prove to those with whom you come in contact that there exists today one of the greatest incentives for doing efficient work that has ever appealed to the railroad men of this or any other country. That incentive is nothing less than the re-establishing of permanent prosperity for the American people. We must all become teachers of economics. The lesson to be taught is that high wages and permanent work depend on production. We must give a fair day's work for a fair day's pay. We must bend every effort toward wiping out the thought that the curtailment of production means more jobs and better living conditions.

The present standard of wages can be and will be maintained if they are earned. They cannot be and will not be maintained if production is decreased in proportion as wages are increased. We Americans receive the best wages for the shortest hours of work that are received by any workmen in the world. In order to maintain and improve this standard we must give full value for what we receive. Getting something for nothing is contrary to the laws of nature. Production is the basis of the solution of our present day problems. Profiteering can and will be wiped out by existing law or by new laws formulated to meet the new conditions. Labor itself has the power to resist unfair practices. Capital and labor are partners. They must co-operate. A spirit of loyalty must be obtained not only between the workman and his boss, but between the boss and his workmen.

Those 200 railroad men in France were a host in themselves. They overcame difficulties that were seemingly insurmountable. They did their work cheerfully, willingly and happily. It was a pleasure to them and their production was phenomenal. If the vast group of railroad workers in America today felt that same spirit of co-operation, that same spirit of comradeship, that incentive to accomplish things because of the spirit of loyalty pervading the work, production would increase, the cost of living would decrease, the present standard of wages would be maintained or bettered and there would be a joy in work that would make for continued peace of mind and prosperity.

*From an address at the General Foremen's Convention.

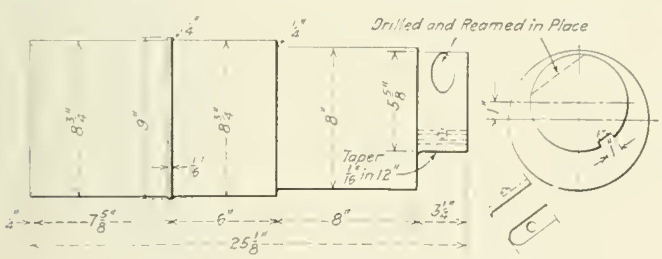


Heavy Ten-Wheel Switcher Built for Chesapeake & Ohio

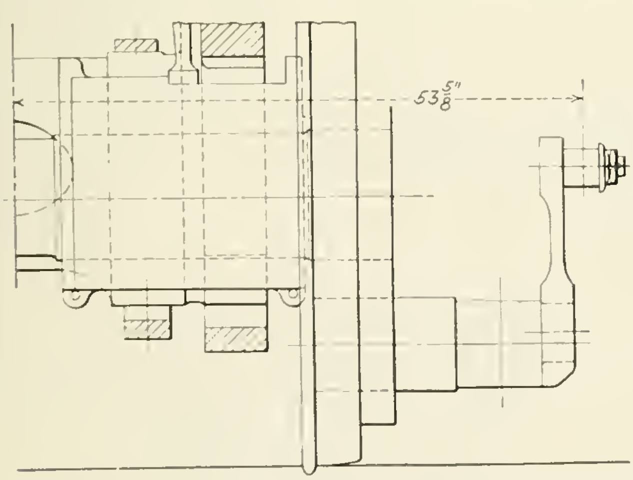
Heavy Switchers Built for the C. & O.

More Power Required to Move Heavy Trains
New Locomotives Have 63,000 lb. Tractive Effort

The demands made upon switching locomotives by the heavy tonnage trains of the present day have resulted in the building of some very heavy 10-wheel switching locomotives for the Chesapeake & Ohio. The tonnage of many trains has grown to such proportions that they are beyond the capacity of any locomotives used for switching except the Mallet type locomotives. These 10-wheel switching locomotives are the largest and heaviest non-articulated switchers ever built. The total weight on drivers is 295,000 lb. and the tractive effort is 63,000 lb. They were designed by the mechanical department of the Chesapeake & Ohio with the co-operation of the American Locomotive Company, which built the locomotives at its Richmond works. Some very interesting and difficult problems were encountered in the design of these locomotives, but the results have been very satisfactory.



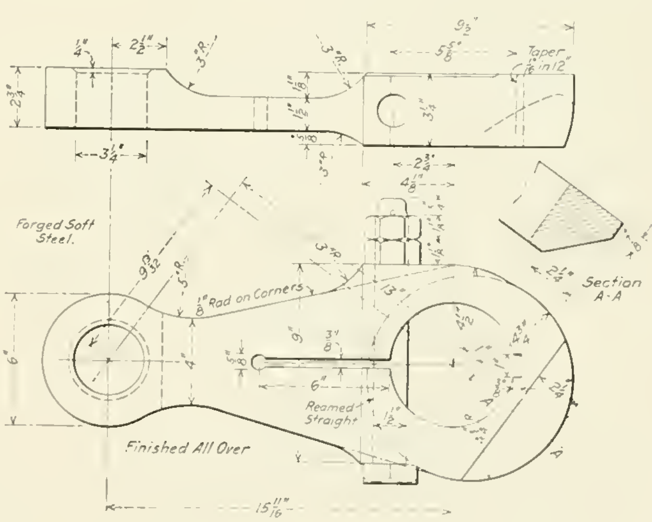
Main Crank Pin with Offset Eccentric Boss



Application of the Eccentric to give Clearance Above the Rail

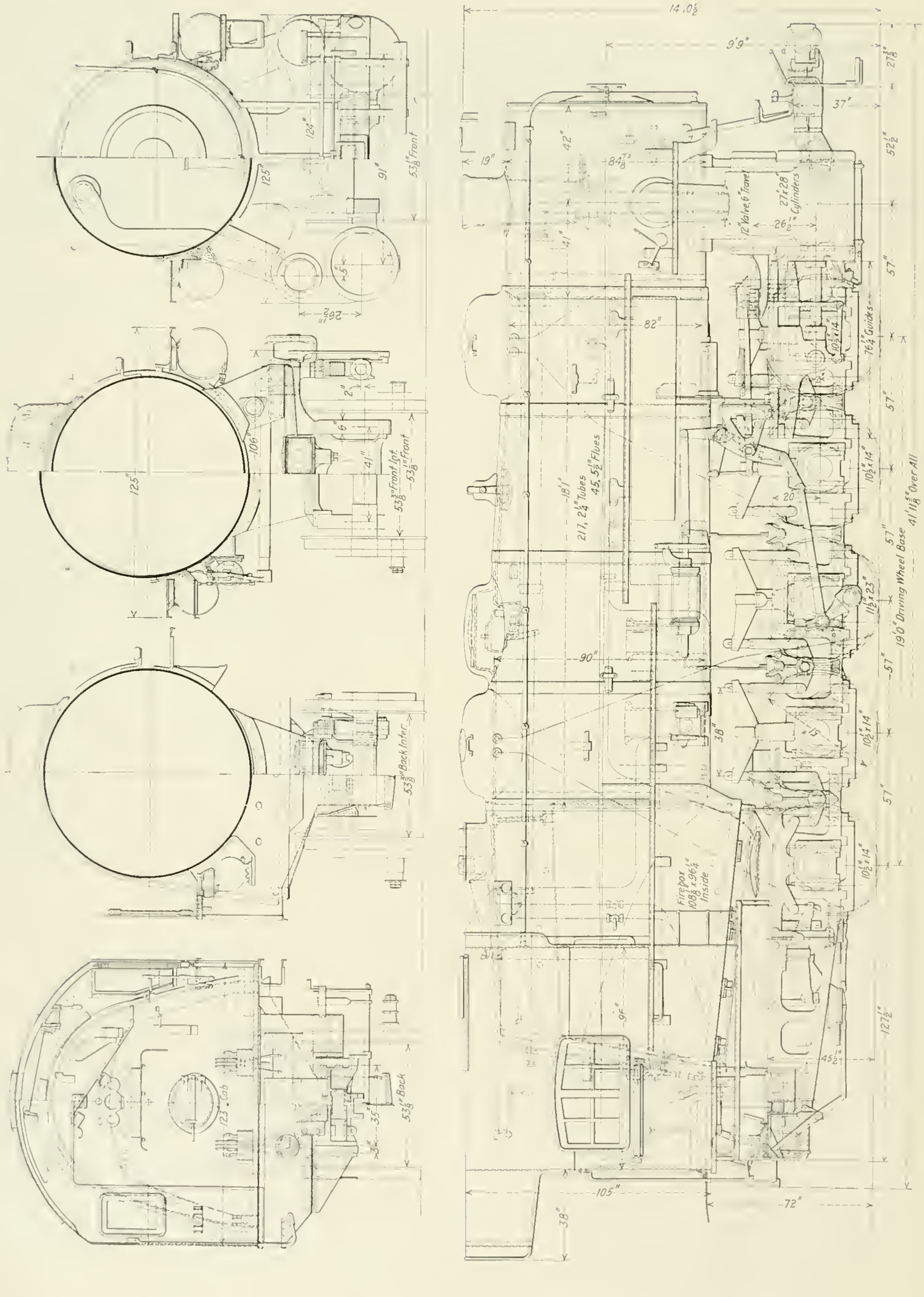
The driving wheels all have flanged tires 5¾ in. wide and in order to keep the wheel base at a minimum, are made as small in diameter as practicable. With 51-in. diameter driving wheels spaced as closely as posible, the total wheel base is only 19 ft. and these locomotives can pass over curves of 14 deg. without the use of lateral motion driving boxes.

The steam pressure is 185 lb. per sq. in. and the cylinders are 27 in. in diameter with a 28-in. stroke. The small driving wheels with this 28-in. stroke and the large crank pins necessary for an engine of this high power made the question of clearance of main rod straps and eccentric cranks a rather difficult problem. The hub of the eccentric crank was kept above the rails the required distance by making the main crank pin boss eccentric, as shown in the drawings.



The Eccentric Crank

The side rods are of a design differing from the usual arrangement. Instead of the usual rear knuckle joint connection the fourth crank pin is made with two journals, and the back crank pin is extended in a manner similar to the style used on many American type eight-wheel locomotives. The back section rod is independent of the forward side rods and



Elevations and Sections of the Ten-Wheel Switcher Built by the American Locomotive Company for the Chesapeake & Ohio

is on the outside, in line with the main rod. The guides and crosshead shoe being solid bronze with very liberal bearing surfaces, designed to give long wear.

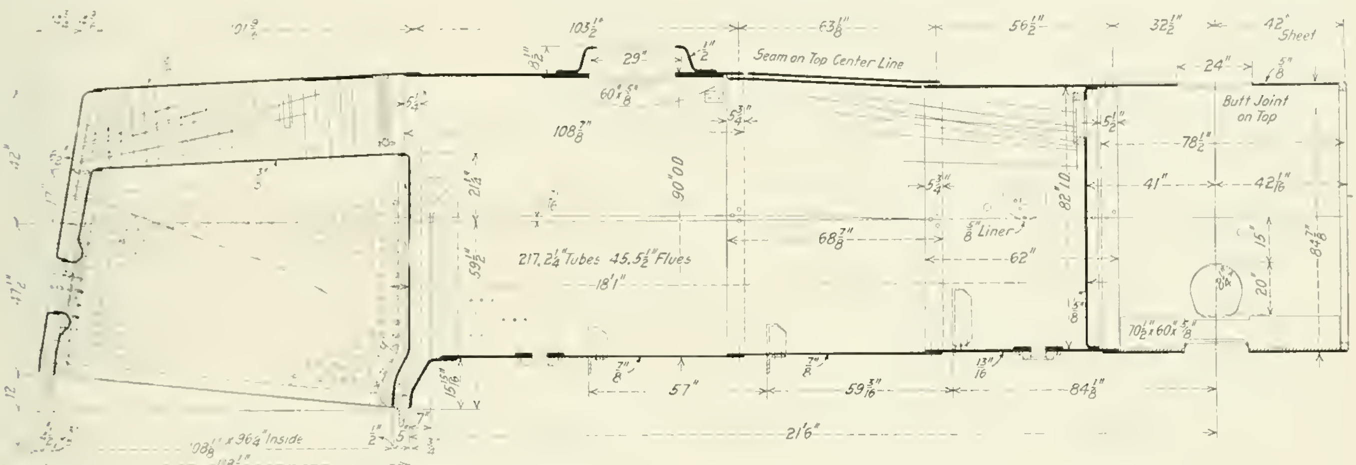
The total length of this locomotive from the front bumper to the tender end sill is 75 ft. 9¼ in., the overall height is 14 ft. 11¾ in. and the width over running boards 10 ft. 5 in. The locomotive frames are 6 in. wide and have ample depth over the pedestals to provide the required strength to support the heavy weight of the locomotive. The journals of the main driving axles are 11½ in. by 23 in. and the other four axles have journals 10½ in. by 14 in.

The cab fittings are arranged on the backhead in the most convenient location for the engineman and particular care has been taken to afford an unobstructed view in both directions from the cab.

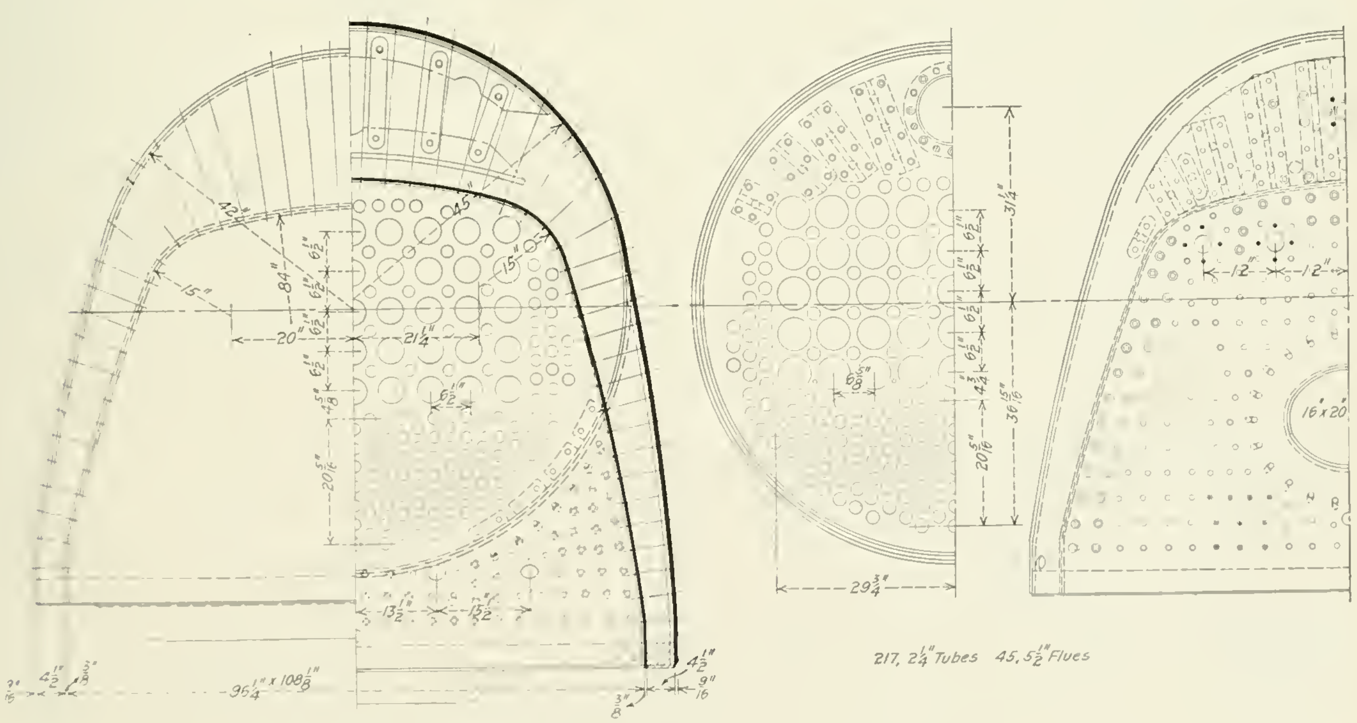
The boiler is of the extended wagon top type with a wide firebox. It has an inside diameter of 88¼ in. at the dome course. The longitudinal seams are on the top center line, have inside and outside welt strips and are strongly riveted. The circumferential seams are lapped 5½ in. at the smokebox, with a double row of 1-in. rivets, 5¾-in. at the two intermediate seams, with double rows of 1¼-in. rivets and 5¼-in. at the firebox with a double row of 1⅛-in. rivets. The boiler is equipped with a Schmidt superheater, having a heating surface of 945 sq. ft. The firebox is 108⅛-in. long by 96¼ in. wide inside, has an average height of 72⅝-in. and a grate area of 72.2 sq. ft.

The tender tank is built unusually low and long and the side plates of the coal space are set in to permit an unobstructed view toward the rear. The tank is 32 ft. long by 10 ft. wide, by 5 ft. high inside, and has a water capacity of 15,000 gallons. The coal space has a capacity of 15 tons. The tender frame is of cast steel, having side sills 10 in. deep and intermediate sills 13 in. deep. The vertical webs of these sills are 1-in. thick and are very strongly ribbed and webbed, making a most rigid frame that will withstand any stress that may be put upon it in heavy switching service.

The tender trucks are of the same design as those used under the tenders for the Chesapeake & Ohio Mallet type locomotives. The truck side frames are 6 in. wide and are



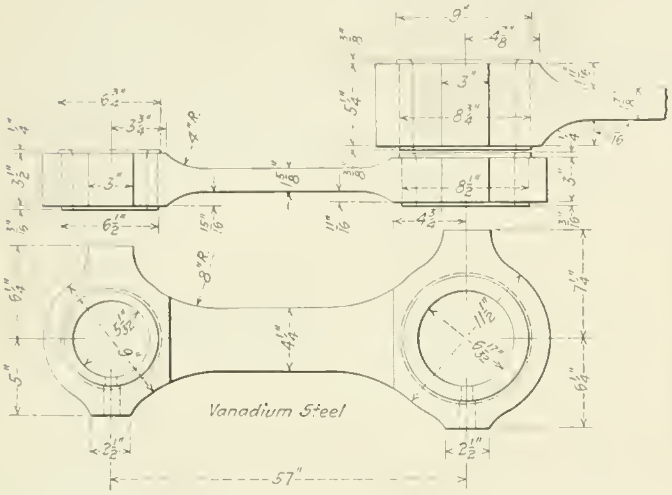
Extended Wagon Top Boiler for the Chesapeake & Ohio Ten-Wheel Switching Locomotive



Cross Sections of Boiler for the Chesapeake & Ohio Heavy Switcher

of cast steel. The bolsters are also of cast steel and are supported by triple elliptic steel springs. The wheel base is 5 ft. 10 in., and the wheels 33 in. in diameter and the journals 6 in. by 11 in.

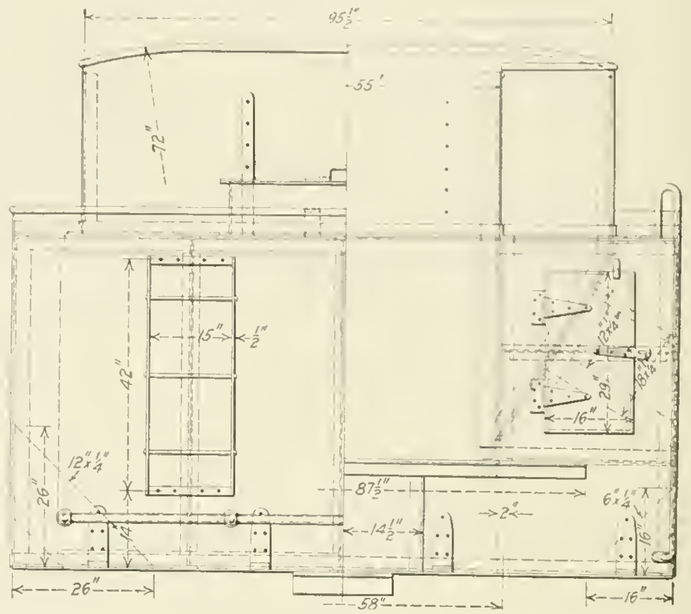
The specialties include the Cole long main driving boxes, Watters pneumatic sanders, Nathan lubricators and non-lifting injectors, Hancock combined stop and check valves and hose strainers, "Loco" incandescent headlight equipment,



Back Section Rod Outside of Side Rods and in Line with Main Rod

Consolidated safety valves, Franklin pneumatic grate shakers, Lewis power reverse gear, Economy radial buffer, Farlow-Westinghouse draft gear, Sharon tender and pilot couplers, Commonwealth cast steel pilot beam and tender frame, Hunt-Spiller gun iron cylinder and valve packing rings and steam chest bushings, Cambria Coffin process axles, Schmidt superheater and Westinghouse-American brakes with two 9½-in. pumps. The piston rods and crank pins, the frames and the main and side rods are of vanadium steel.

In the design and construction of these locomotives careful attention was given to the smallest detail so that the tractive effort might be a maximum without any unnecessary weight being added to the locomotive as a whole. The service obtained from them since they were placed in service in February, 1919, has been very satisfactory. They have not only handled the heavy trains easily but have proved to be as well adapted to a lighter switching service as the medium sized locomotives.

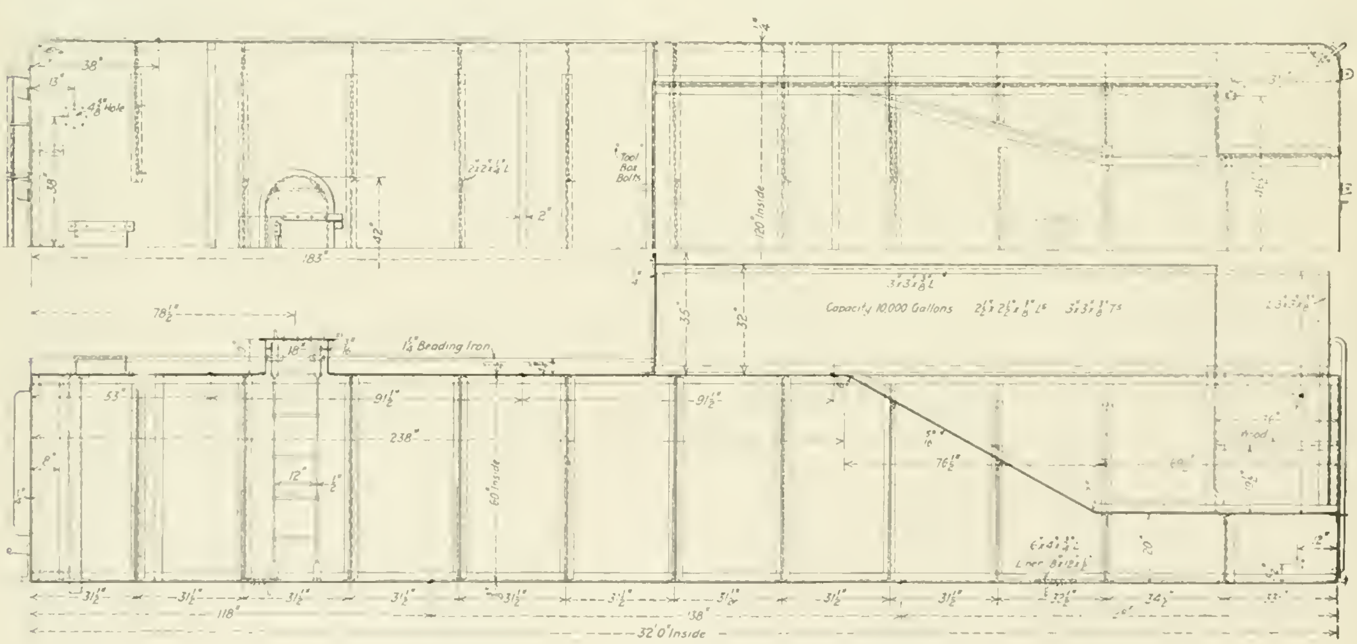


Half Front and Rear Elevations of Tender for C. & O. Ten-Wheel Switcher

The principal weights, dimensions and ratios are as follows:

General Data

Gage	4 ft. 8½ in.
Service	Switching
Fuel	Soft coal
Tractive effort	63,000 lb.
Weight in working order	295,000 lb.
Weight on drivers	295,000 lb.
Weight of engine and tender in working order	478,100 lb.
Wheel base, driving	19 ft.
Wheel base, total	19 ft.
Wheel base, engine and tender	60 ft. 3¼ in.



Tender Tank for Ten-Wheel Switching Locomotive

Ratios

Weight on drivers ÷ tractive effort	4.68
Total weight ÷ tractive effort	4.68
Tractive effort × diam. drivers ÷ equivalent heating surface*	629
Equivalent heating surface* ÷ grate area	70.5
Weight on drivers ÷ equivalent heating surface*	57.4

Total weight ÷ equivalent heating surface*	57.4
Volume both cylinders	18.55 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	277
Grate area ÷ vol. cylinders	3.84
Cylinders	
Kind	Simple
Diameter and stroke	27 in. by 28 in.
Valves	
Kind	Piston
Diameter	12 in.
Greatest travel	6 in.
Wheels	
Driving, diameter over tires	51 in.
Driving journals, main, diameter and length	11½ in. by 23 in.
Driving journals, others, diameter and length	10½ in. by 14 in.
Boiler	
Style	Extended wagon top
Working pressure	185 lb. per sq. in.
Inside diameter of first ring	82 in.
Firebox, length and width	108⅛ in. by 96¼ in.
Tubes, number and outside diameter	217—2¼ in.
Flues, number and outside diameter	45—5½ in.
Tubes and flues, length	18 ft. 1 in.
Heating surface, tubes	2,300 sq. ft.
Heating surface, flues	1,166 sq. ft.
Heating surface, firebox†	232 sq. ft.
Heating surface, total	3,698 sq. ft.
Superheater heating surface	935 sq. ft.
Equivalent heating surface*	5,100.5 sq. ft.
Grate area	72.3 sq. ft.
Tender	
Tank	8-wheel
Frame	Cast steel
Weight	183,100 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	15 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.
†Includes arch tubes.

Rolling Stock Ordered and Built in 1919

New Low Records in Locomotive and Car Orders Production of Freight Cars Greater than in 1918

The number of locomotives ordered for service in the United States during 1919, according to the statistics of the Railway Age, were only 214. This marks a new low record in the history of the railroads of the country. The orders placed by Canadian roads either with American or Canadian builders totaled 58, while orders for export reached a total of 898, a total of all three of but 1,170. In other words, the foreign orders and the domestic together were barely sufficient to bring the total up to the domestic orders alone of the poorest year since 1901, namely, 1908, when only 1,182 locomotives were ordered for domestic service.

Table I—The Locomotive Orders of 1919

For service in the United States	214
For service in Canada	58
For export to other countries	898
Total	1,170

The 1919 totals quoted above compare with figures for 1918 of 2,593 for domestic service in the United States, 209 for Canadian roads and 2,086 for the American forces in France or for export. The total of locomotives ordered for domestic service represents only those locomotives ordered by lumber roads and industrial lines; there are but few orders for railroad service.

Table II—Orders for Locomotives Since 1901

Domestic orders only

Year	Locomotives	Year	Locomotives
1901	4,340	1908	1,182
1902	4,665	1909	3,350
1903	3,283	1910	3,787
1904	2,538	1911	2,850
1905	6,265	1912	4,515
1906	5,642	1913	3,467
1907	3,482	1914	1,265

Domestic and Foreign

	Domestic	Foreign	Total
1915	1,612	850	2,462
1916	2,910	2,983	5,893
1917	2,704	3,438	6,142
1918	2,802	2,086	4,888

The number of locomotives built in the United States and Canada in 1919, according to the compilations of the Railway Age, was 3,272, of which 2,162 were built for domestic use and 1,110 for export. Of the domestic total 2,055 engines are shown as having been built in the United States for use on the railroads in this country and 107 in Canada for use in that country. The totals given are but one-half those of 1918, when 6,475 locomotives were produced in the United States and Canada. It will be noted, however, that the total domestic output of 1919 was considerably above that of the years immediately preceding 1918.

Table III—The Locomotives Built

	United States	Canada	Total
Domestic	2,055	109	2,162
Foreign	.....	.....	1,110
Total			3,272

Comparison with Previous Years

Year	Domestic	Foreign	Total	Year	Domestic	Foreign	Total
1896	866	309	1,176	1908*	1,886	456	2,342
1897	865	386	1,251	1909*	2,596	291	2,887
1898	1,321	554	1,875	1910*	4,441	314	4,755
1899	1,951	514	2,475	1911*	3,143	387	3,530
1900	2,648	505	3,153	1912†	4,403	512	4,915
1901	.....	.....	3,384	1913†	4,561	771	5,332
1902	.....	.....	4,070	1914†	1,962	273	2,235
1903	.....	.....	5,152	1915†	1,250	835	2,085
1904	.....	.....	3,441	1916†	2,708	1,367	4,075
1905*	4,896	595	5,491	1917†	2,585	2,861	5,446
1906*	6,232	720	6,952	1918†	3,668	2,807	6,475
1907*	6,564	798	7,362				

*Includes Canadian output.
†Includes Canadian output and equipment built in railroad shops.

FREIGHT CARS ORDERED AND BUILT

The number of freight cars ordered for domestic service in the United States in 1919 totaled only 29,893, marking a figure so low as to make almost ridiculous a comparison with the domestic orders of previous years. There were ordered for service in Canada 3,837 freight cars and for export to other countries 3,994. These totals compared with domestic orders placed in 1918 for cars to be used in the United States of 114,113; for roads in Canada, 9,657, and for the A. E. F. and for export to other countries, 53,547.

Table IV—The Freight Car Orders of 1919

For service in the United States*	22,062
For service in Canada	3,837
For export to other countries	3,994
Total	29,893

*Including 15,295 tank cars.

The exceptionally small domestic total in 1919 resulted from the fact that the United States Railroad Administration has placed no orders for cars in 1919 and that the railroads have ordered but a very few. In fact, the larger part of the orders that have been reported have been placed by private car lines, over two-thirds of the orders being for tank cars.

The orders for export, totaling in the neighborhood of but 4,000, were considerably below the totals of 1917 and 1918. They were less than one-fourth as great as those for 1915, the year in which the war demands began to make themselves effective. They were less than one-twelfth as great as in 1918. The domestic, Canadian and foreign orders combined were only slightly over one-third as great as the domestic orders alone in the poorest year since 1901, namely, 1908, when but 62,669 cars were ordered for domestic service.

Table V—Orders for Freight Cars Since 1901

Domestic orders

	Freight cars		Freight cars
1901	193,439	1908	62,669
1902	195,248	1909	189,360
1903	108,936	1910	141,024
1904	136,561	1911	133,117
1905	341,315	1912	234,758
1906	310,315	1913	146,732
1907	151,711	1914	80,264

Domestic and foreign

Year	Domestic	Foreign	Total
1915	109,792	18,222	128,014
1916	170,054	35,314	205,368
1917	79,367	53,191	132,558
1918	123,770	53,547	177,317

The production of freight cars in the United States in 1919 has totaled 156,764, of which 94,981 were for domestic service and 61,783 were for export. The total of 156,764 represents by no means as large a share of the productive capacity of the country as might be wished. It is, however, considerably in excess of the output of the car-building plants of the United States of 108,044 (124,708 including Canada) in 1918, or of 139,643 (151,401 including Canada) in 1917. In fact, it has been exceeded but twice since the big total of 284,188 (including Canada) in 1907, namely, in 1910, when there were produced in the United States and Canada 180,915 cars, and in 1913, when 207,684 were produced.

Table VI—Freight Cars Built

	United States	Canada	Total
Domestic	94,981	6,391	101,372
Foreign	61,783	30	61,813
	156,764	6,421	163,185

Comparison with Previous Years

Year	Freight: Domestic	Freight: Foreign	Freight: Total
1899	117,982	1,904	119,886
1900	113,070	2,561	115,631
1901	132,591	4,359	136,950
1902	161,747	2,800	162,599
1903	153,195	1,613	152,801
1904	60,955	1,995	60,806
1905*	162,701	5,305	165,155
1906*	236,451	7,219	240,503
1907*	280,216	9,429	284,188
1908*	75,344	1,211	76,555
1909*	91,077	2,493	93,570
1910*	176,374	4,571	180,945
1911*	68,961	3,200	72,161
1912†	148,357	4,072	152,429

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
	Domestic	Foreign	Total	Domestic	Foreign	Total	total
1913	176,049	9,618	185,667	22,017	....	22,017	207,684
1914	97,626	462	98,088	6,453	....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	....	....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708

The unfortunate feature in the comparatively large output figures of 1919 is the small number for domestic use. While the total output is large, it will be noted that that for domestic use alone, while it is above the level of 1918, when 67,063 cars were produced for use in the United States, is not up to the totals of 1916 or 1917 even, in which years the output of freight cars was not sufficient to keep up with the increasing demands of the business offered for railway transportation.

FEW PASSENGER CARS BUILT IN 1919

The figures showing the new orders and the production of passenger cars in 1919 indicate that that industry has as yet by no means recovered from the practical cessation of business resulting from the war and its attending circumstances. The number of passenger cars ordered in 1919 totaled 782, of which 292 were for service in the United States, 347 for Canada and 143 for export. Owing to the fact that there have been a number of passenger car orders placed within the last few weeks these numbers are considerably in excess of those of 1918, when 131 cars were ordered for domestic service and 26 for export, but, of course, they are not at all up to the totals for 1917.

Table VII. The Passenger Car Orders of 1919

For service in the United States	292
For service in Canada	347
For export to other countries	143
Total	782

Table VIII. Orders for Passenger Cars Since 1901

Domestic orders only

	Passenger cars		Passenger cars
1901	2,879	1909	4,514
1902	3,459	1910	3,881
1903	2,310	1911	2,623
1904	2,213	1912	3,642
1905	3,289	1913	3,179
1906	3,402	1914	2,002
1907	1,791	1915	3,101
1908	1,319		

Domestic and Foreign

Year	Domestic	Foreign	Total
1916	2,544	109	2,653
1917	1,124	43	1,167
1918	131	26	157

The production of passenger cars in the car building plants of the United States in 1919 (excluding Canada), totaling 466, of which 306 were for domestic use and 85 for export, is likewise far below the output for 1918, when 1,573 cars were built, including 1,481 cars for domestic use and 92 for export. The output of passenger cars in 1919 was the lowest since the compilation of these figures was begun.

Table IX. Passenger Cars Built

	United States	Canada	Total
Domestic	306	160	466
Foreign	85	...	85
	391	160	551

Comparison with Previous Years

Year	Passenger: Domestic	Passenger: Foreign	Passenger: Total
1899	1,201	104	1,305
1900	1,515	121	1,636
1901	1,949	106	2,055
1902	From 1902 to 1907 passenger car figures in these two columns included in corresponding frt. car columns.		1,948
1903			2,007
1904			2,144
1905*			2,551
1906*	.....	...	3,167
1907*	.....	...	5,457
1908*	1,645	71	1,716
1909*	2,698	151	2,849
1910*	4,136	276	4,412
1911*	3,938	308	4,246
1912†	2,822	238	3,060

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
	Domestic	Foreign	Total	Domestic	Foreign	Total	total
1913	2,559	220	2,779	517	....	517	3,296
1914	3,310	56	3,366	325	....	325	3,691
1915	1,852	14	1,866	83	.....	83	1,949
1916	1,732	70	1,802	37	....	37	1,839
1917	1,924	31	1,955	45	....	45	2,000
1918	1,480	92	1,572	1	....	1	1,503

The orders on hand for passenger cars at present promise a somewhat larger year from the production standpoint in 1920 than in 1919.

Developments in the Shop Labor Situation

Summary of Reports Showing Changes in Wages and Hours of Various Classes of Employees since 1917

The United States Railroad Administration has prepared very complete reports of the number of employees, rates of pay and the average of compensation in December, 1917, and each month from January to July, 1919, at the request of the Senate. This information was submitted to the president of the Senate by Director General Hines, and a summary of the data relating to the shop crafts is shown in the tables below.

There has been a widespread belief that there was a considerable increase in the number of railway employees and the total number of hours worked. The report shows, however, that while more employees are now used for a similar amount of work, the increase has resulted largely from the effect of the introduction of the eight-hour day in reducing the number of hours worked by each employee. Considering all classes of employees, the number employed by the railroads under government control increased from December, 1917, to July, 1919, by 11.2 per cent, as shown in the following table. During this same period the number of hours worked decreased 3.9 per cent and the total compensation increased 36 per cent.

Considering only the shop crafts, the average increase in the number of employees has been 19.2 per cent. The change in the average number of hours worked per employee varies greatly for the different classes. The general foremen were the only class showing an increase, the average number of days worked in July, 1919, being 29.9 per cent as compared with 27.1 per cent in December, 1917. On the other hand, the average number of hours worked by hostlers during July, 1919, was 97 hours less than in December, 1917, and by car inspectors 89 hours less. The average increase in the unit compensation for all classes of employees was 53 per cent. The increases for shop crafts in most cases were considerably greater. Taking into account the increase granted in September, 1919, the rate of pay for car inspectors increased 117 per cent. The only classes of employees in the mechanical department receiving less than the average percentage of increase were the machinists, boilermakers and blacksmiths. It should be noted in this connection that these crafts are among the highest paid classes of railroad employees, and although they have not received increases proportionate to the other crafts this is quite consistent with the

NUMBER OF EMPLOYEES AND AVERAGE HOURS WORKED

Class 1 Roads Under Federal Control December, 1917, and July, 1919

Class of Employee	Number of employees December, 1917	July, 1919	Increase or Decrease	Average hours worked per employee: July, 1919	Average hours worked per employee: December, 1917	Decrease or Increase
General foreman, M. E. department	1,665	1,707	42	days 29.9	days 27.1	Inc. 2.8
Gang and other foremen, M. E. department	18,429	23,592	5,163	days 28.4	days 28.9	.5
Machinists	42,973	59,067	16,094	206	248	42.
Boiler makers	13,469	18,413	4,944	213	253	40.
Blacksmiths	8,369	9,898	1,529	200	224	24.
Painters and upholsterers	9,878	12,632	2,754	194	225	31.
Electricians	9,894	13,200	3,306	days 26.8	days 29.0	2.2
Air-brake men	5,846	7,781	1,935	217	280	63.
Car inspectors	20,763	24,258	3,495	239	328	89.
Car repairers	66,443	80,417	13,974	209	240	31.
Mechanics' helpers and apprentices	92,018	107,263	15,245	208	251	43.
Hostlers	8,493	10,687	2,194	240	337	97.
Enginehouse men	60,439	68,685	8,246	250	318	68.
Carpenters	50,848	50,854	6	201	234	33.
Total	409,527	488,454	78,927			

This report is compiled according to the classification prescribed by the Interstate Commerce Commission in accordance with the Act to regulate commerce, which classification has been the prescribed form since July 1, 1915.

The classification of employees prescribed by the Interstate Commerce Commission and used in the reports, does not correspond with the classification of employees used in the wage orders of the Railroad Administration, with the result that employees in a given class (of wage orders) receiving either higher or lower wages may be included with the employees of another class (of the Interstate Commerce Commission classification).

A comparison of the number of employees in January, 1919, and December, 1917, is misleading, because in December, 1917, on account of the extreme cold weather, much outside work had of necessity to be suspended. In addition, there was a scarcity of labor, in consequence of the competition of war industries, and the generally higher wages paid by them which had attracted many employees from railroads.

On the contrary, the weather was exceptionally mild in January, 1919, and permitted the prosecution of an unusual amount of outdoor work; moreover, the labor supply was relatively greater because of higher wages, and in consequence of the cessation of war activities. In addition, the Railroad Administration had not yet been able fully to reduce its forces from what had been necessary to handle the peak load which was reached about the time of the signing of the armistice a couple of months earlier.

In considering the number of employees in view of the changes in the working conditions between 1917 and 1919, the number of hours worked should be carefully noted.

DAILY AND HOURLY RATES OF PAY—CLASS I ROADS UNDER FEDERAL CONTROL

Class of employee	Compensation Per day: July 1919	Per day: December 1917		Per hour: July 1919	Per hour: December 1917		Per cent Change in unit Compensation
General foremen, M. E. department	8.68	5.00	....	....	....	....	74
Gang and other foremen, M. E. Department	6.88	4.23	....	....	....	....	63
Machinists	....	....	*.730*	.690	.509	*43*	36
Boiler makers	....	....	*.734*	.695	.504	*46*	38
Blacksmiths	....	....	*.734*	.695	.504	*46*	38
Carpenters	....	....	*.657*	.584	.350	*88*	67
Painters and upholsterers	....	....	*.676*	.611	.382	*77*	60
Electricians	.538	3.22	....	....	....	*77*	67
Air-brake men	....	....	*.651*	.611	.459	*81*	70
Car inspectors	....	....	*.700*	.610	.323	*117*	89
Car repairers	....	....	*.663*	.591	.366	*81*	61
Mechanics' helpers and apprentices	....	....	....	.457	.296	.	54
Hostlers	....	....	....	.553	.329	....	68
Enginehouse men	....	....	....	.419	.242	....	73

Note—Italic figures indicate estimate of increase to shopmen in September, 1919, retroactive to May 1, 1919.

original policy of the wage board, which recommended increases on a graduated scale.

It should be noted, also, that a comparison between the rates of pay in 1919 with the single month of December, 1917, is likely to be misleading, because some classes of employees had prior to December, 1917, obtained reductions in hours which resulted in their average compensation per hour being substantially increased, or increases in rates of pay, or both, whereas other classes of employees secured corresponding treatment only after December, 1917.

	Number of employees	Increase in percentages as compared with December, 1917
1917—December	1,703,748	...
1919—January	1,848,774	8.5
February	1,840,197	8.0
March	1,823,220	7.0
April	1,830,093	7.4
May	1,864,561	9.4
June	1,863,741	9.4
July	1,894,287	11.2

The records do not indicate separately the amount of punitive overtime, but it is probably true that in December, 1917, numerous classes of employees were working punitive overtime to a larger extent than in July, 1919.

	Total number of hours worked	Increase in percentage as compared with December, 1917
1917—December	434,252,656	....
1919—January	440,699,731	1.5% increase
February	375,204,721	13.6% decrease
March	398,689,315	8.2% decrease
April	393,578,428	9.4% decrease
May	409,674,681	5.7% decrease
June	396,385,011	8.7% decrease
July	417,182,290	3.9% decrease

Based on comparisons between December, 1917, and July, 1919, Director General Hines reported that the average percentage of increase in the unit compensation for all railroad employees was 53 per cent, which would be increased to approximately 56 per cent by including the shopmen's increase, but that because of the reduction in hours the average increase in monthly compensation was 32.9 per cent or 35.3 per cent, taking into consideration the shopmen's increase. The wages in December, 1917, were, however, on a higher basis than the average for that year, because of the large number of increases made by the railroads during the last year of private management, and the increase for July, 1919, over the average for 1917 was given by Mr. Hines as 45.3 per cent.

	July, 1919	December, 1917
Number of employees	1,894,287	1,703,748
Days worked	6,122,435	5,819,486
Hours worked	368,202,810	387,696,788
Total compensation	$226,140,935	$153,039,988
Average compensation per day for employees reported on a daily basis	4.93	3.52
Average compensation per hour for employees reported on an hourly basis	.532	.342

Per cent of increase for July, 1919, over December and calendar year 1917, 35.3 per cent.

Average Monthly Compensation and Average Days or Hours Worked Per Employee
Class I Roads Under Federal Control
July, 1919, Compared with December, 1917, and Monthly Average for Calendar Year, 1917

Class of employee	Average monthly compensation per employee: July, 1919	December, 1917	Calendar year 1917	Per cent increase July, 1919, over: December, 1917	Monthly average for calendar year, 1917	Average hours worked per employee: July, 1919	December, 1917
General foremen—M. E. Department	259.51	135.69	138.37	91.3	87.5	*d*29.9	*d*27.1
Gang and other foremen—M. E. Department	195.41	122.26	112.64	59.8	73.5	*d*28.4	*d*28.9
Machinists	142.18	126.11	116.20	12.7	22.4	206	248
Boiler makers	147.74	127.67	118.76	15.7	24.4	213	253
Blacksmiths	136.35	110.92	104.84	22.9	30.1	200	224
Carpenters	117.30	81.70	78.35	43.6	49.7	201	234
Painters and upholsterers	118.64	85.89	79.22	38.1	49.8	194	225
Electricians	143.97	93.59	75.84	53.8	67.7	*d*26.8	*d*29.0
Air-brake men	132.37	100.59	90.53	31.6	46.2	217	280
Car inspectors	145.71	106.03	95.02	37.4	53.3	239	328
Car repairers	123.33	87.77	82.81	40.5	48.9	209	240
Mechanics' helpers and apprentices	95.13	74.17	68.52	28.3	38.8	208	251
Hostlers	132.73	110.80	103.73	19.8	28.0	240	337
Enginehouse men	104.55	76.83	69.56	36.1	50.3	250	318

Note—*d* indicates days worked.

REPORT ON COST OF LIVING DOES NOT JUSTIFY WAGE INCREASE.

Executive officers of the railroad shop crafts affiliated with the Railroad Employees' Department of the American Federation of Labor called on Director General Hines on December 20, just before the Cummins bill was passed by the Senate, to discuss, according to a statement issued by the Railroad Administration, "the question of the cost of living," which is taken to mean that they renewed their request for a general increase in wages which has been held in abeyance since August, when the President and Mr. Hines asked them to wait a reasonable time to allow the government an opportunity to try to reduce the cost of living. According to the official announcement, Mr. Hines explained that he hoped to be able in a few days to give more definite advice on this subject, and it was agreed that a further conference would be held a few days later.

On December 22 Attorney General Palmer issued a statement in the way of a report to the public on the results of the government's campaign against the high cost of living, in which he announced that since August it had been held in check, whereas statistics had usually shown a rise in prices during the fall months and that a drop may be expected between January 1 and March 1. The report, which was authorized by a committee of government officials that have taken part in the campaign, including Mr. Hines, is understood to form the basis of the government's answer to any further wage demands.

The demands of the shop employees were originally presented in January and were based on an increase for skilled mechanics from 68 to 85 cents an hour. Increases ranging from 4 to 9 cents an hour were granted them in August by way of readjustment at the time. It was announced the government could not then consider further increases to meet the cost of living, because they would tend to increase it still further. Most of the other organizations of railway employees also presented demands, which have also been held in abeyance. What position they will take in view of the report that the cost of living statistics do not justify further increases has not yet been disclosed. It was stated that no definite date had yet been set for the conference with the shopmen, but B. M. Jewell, head of their committee, was quoted as saying they had no intention of striking.

The Inspection of Freight Equipment

First of a Series of Articles Describing the System of Handling Inspection Used on the C. M. & St. P.

BY L. K. SILLCOX
Master Car Builder, Chicago, Milwaukee & St. Paul

These instructions, effective date of issue, supersede all previous or heretofore existing regulations, and shall not be modified or revised, except by authority of the undersigned.

Car foremen will be held individually responsible for the enforcement of these instructions, and are to notify the master car builder in case any condition arises wherein they find it impractical or impossible to maintain the regulations as set forth.

GENERAL.

The data which follows has been worked up through the co-operation of the transportation department, the operating department and all concerned, having one purpose in mind; namely, the safe and prompt movement of freight equipment. The conclusions reached as set forth are the results of years of experience and the best judgment of the combined effort of those interested on the railroad. It is, therefore, necessary and obligatory that these instructions shall be lived up to literally, and no excuse whatever will be accepted for disregard of them. Good judgment is necessary in putting these regulations into practice.

Knowing that certain things must be done, and issuing instructions to do them, does not always mean they will be carried out or that the instructions issued will be complied with. Something more is required. The men in charge must be capable not only of issuing instructions, but capable of knowing whether these instructions are being complied with or not, and they should also be capable of turning the interpretation over to their assistants in workable form and selecting men who are capable of complying with these regulations.

If this statement is true, then we should have thorough capable and efficient foremen in charge of all stations who know when a car is inspected and how to inspect it as well. They should know when a car is properly repaired and how to repair it. If they are capable of doing this they should then be capable of selecting the right man to see that this work is properly performed, and so on right down to the point of seeing positively that neglect and inefficiency are never allowed to creep into the service.

Inspectors should be given trains to handle, as outlined on the charts on page 21, and they must be permitted to hold them a sufficient length of time to give each car the needed inspection and repairs or to shop defective cars out for repairs. After an inspector has shopped a car for defects which make it unsafe to be continued in service, no one should be permitted to cause such a car to be placed back in service until the repairs for which the car was shopped have been properly made, or improper repairs corrected. One giving or assuming such authority would by his act destroy the effort made toward obtaining safe movement and would be a promoter of ill results. It should be considered just as serious and dangerous for one to remove a bad-order card from a defective car and permit it to go into service without necessary repairs being made, or permit a car to go into service with a bad-order card on it without the repairs being made, as it would be for one to change a signal in front of an approaching train operating under the automatic block system.

Cars once inspected and passed as being fit for service should be in such condition that when inspected again at the next inspection point they will not be shopped out for defects that existed at the time of previous inspection, neither should they fail while in movement due to such defects; in other words, should an inspector pass a car as being safe and fit for loading at Chicago, that car should be in condition to continue through to Tacoma or any other destination without being shopped out or breaking down in movement, due to defects existing when the car was inspected at Chicago. When a car is repaired on the shop tracks at Minneapolis for movement to Omaha for loading, it should not be necessary to shop it for defects that existed when it was placed on the shop tracks, or for improper repairs made at Minneapolis, on or before its arrival at Omaha. No car should be placed for loading until first inspected and given needed repairs. Unless we are able to obtain these desirable conditions, our inspection or our repairs are not uniform, or our supervisors are not capable or efficient, or some one is removing bad-order cards or causing cars to leave inspection or repair yards before they are in proper condition for service.

Such practices, if they do exist, must be corrected or we cannot expect to establish the results which are required for safe and economical operation. Uniform inspection and repairs mean less loss of life and limb of passengers and trainmen, greater car mileage, fewer accidents, less destruction of equipment and property, less repeated shopping of cars, greater car supply, less need for the purchase of new equipment, decreases in the cost of operation and maintenance, prompt handling of business, greater satisfaction to shippers, better earnings for railroads and a more satisfactory dividend for stockholders.

EXAMINATION OF CAR INSPECTORS

A copy of these instructions will be issued to all car inspectors. They will be examined by their respective foremen, general foremen or district general car foremen. Inspectors are required to sign an acknowledgement as having received and understood these instructions, and all foremen or chief inspectors will keep complete information of this in their offices for present and any future employees of this class on the following form:

Record of Examination of Freight Car Inspectors

Name .... Inspector at .... Station, has been examined for (kind) .... Car Inspector. Answered correctly on first examination .... or ...... per cent, out of .... questions put to him.

Answered correctly on second examination ...., or .... per cent. out of .... questions put to him.

Answered correctly on third examination ...., or .... per cent. out of .... questions put to him.

OK to be shown opposite numbers of questions answered correctly, and X after numbers of questions answered incorrectly. After second or third examination, the questions marked X, if answered correctly, will be marked K.

QUESTION NUMBERS

Under Question Numbers the question should be given with ample space provided for the proper marking on standings.

Examined by.........................
Car Foreman.

....
General Car Foreman.

....
Asst. M. C. B. or Dist. G. C. F.

QUALIFICATIONS OF FREIGHT CAR INSPECTORS

A—Applicant to be eligible as car inspector must have one year or more experience in the car department as a car repairman or builder.

B—The applicant must be between the ages of 21 and 45 years.

C—The applicant must pass the examination for sight and hearing.

D—The applicant must be able to read manuscript and print.

E—The applicant must write all answers to questions as shown in the examination, after he has studied them for at least 30 days.

F—The applicant must answer 75 per cent of the questions of the examination orally from memory.

G—The applicant if failing in the first examination may be examined again in 30 days.

H—The applicant failing in the second examination may again be examined for a third time within 30 days.

I—The applicant failing for the third time will not be considered eligible as an inspector.

J—A record of examination of the applicant will be kept in the file of the local car foreman for reference.

K—No inspector will be permitted to remain in service as an inspector unless he has complied with the above requirements.

L—Examination of car inspectors will be made by the car foreman, general car foreman, district general car foreman or assistant master car builder.

EXAMINATION QUESTIONS FOR FREIGHT CAR INSPECTORS

1. Q—What are the duties of a car inspector?

Answer—To inspect all cars, keep such records as he may receive instructions to keep from proper officers, and to see that no cars are allowed to go forward which have defects which render them unsafe or that have any Interstate Safety Appliance defects, and when not engaged in inspecting to repair and assist in making such repairs to the equipment as is needed to improve its condition.

2. Q—What is the most important duty of an inspector?

Answer—To see that cars and lading are in a safe and proper condition to go forward over the route they are intended to pass.

3. Q—What parts of a car require the most careful inspection?

Answer—Wheels for various defects, especially seams in the throat of the flange, loose wheels, arch bars, column bolts and nuts, foundation brake gear, including the condition of hangers, cotter keys and pins, ratchet pawls, keys and wheels, draft or pulling attachments, doors and roofs of box and other house or stock cars. The lading, especially where its safe movement depends on blocks, stakes, wires and other fastenings, or is improperly distributed and liable to contribute to derailments or heated journals. Also all safety appliance defects, as covered by the interstate laws, journal box bolts and nuts, journal bearings, journals, axles and lubrication.

4. Q—Are the parts mentioned above the only ones which should receive careful attention when inspecting cars?

Answer—No. All parts of a car should be given attention and consideration, as it is well known that a nut or cotter key missing from certain parts of cars of some construction permits parts to fall on the track, that might cause an accident and be attended with a considerable loss of property, if not loss of life.

5. Q—Why is special mention made of seams in the throat of wheel flanges and loose wheels?

Answer—These defects are at times very difficult to discover and frequently cause serious and expensive accidents.

6. Q—Why are arch bars, column bolts and nuts mentioned?

Answer—It is well known that it often happens that a very small crack or fracture in an arch bar results in its failure. A broken column bolt or nuts missing from the column bolt allows the bars to distort and fail, which frequently cause accidents.

7. Q—Why are foundation brake gear and certain derailed parts mentioned?

Answer—For the reasons given in the answer to Question No. 4, also for the reason that if the foundation brake gear should become disconnected the brake would be inoperative, and if the foundation brake gear should be too low when the car is loaded it will strike switch rails and crossings and might cause an accident or a derailment. In addition, the hand brakes should be maintained in a good operative condition at all times, so that when a car is being handled alone its speed can be controlled by the use of hand brakes.

8. Q—Why is mention made of draft or pulling attachments?

Answer—It is necessary that certain essential parts of the various forms or types of such attachments be maintained to a certain standard of efficiency to insure safe movement of the car.

9. Q—Why are doors and roofs of box and other house or stock cars mentioned?

Answer—Doors and fixtures frequently become defective, to the extent that the doors are liable to swing out and strike a passing train or fall on the track, and roofs, on account

of faulty construction or decay or age, are liable to be blown off and fall on the track and cause an accident.

10. Q—Have you any detailed instructions relative to the way the different character of lading should be placed on cars and secured to insure its safe movement over railroads?

Answer—Yes. The latest revised "Rules Governing the Loading of Stone, etc., Loading and Carrying of Structural Materials, Plates, Rails, Girders, etc.," as prescribed by the Master Car Builders' Association.

11. Q—Where it is found that these rules and cuts do not apply to lading being prepared for shipment, what should be done?

Answer—Special instructions must be asked for.

12. Q—Do you understand that railroads are liable to a fine for hauling cars with Safety Appliance Act defects?

Answer—I do.

13. Q—What do the Safety Applicance Act defects consist of?

Answer—Defective couplers and parts that make the couplers inoperative to the extent that they will not couple in impact, or if the coupler is less than 31½ inches or more than 34½ inches from the top of the rail to the center line of the coupler shank, defective uncoupling mechanism, hand or air brakes, hand holds, steps, ladders, running boards or other parts covered, and to be found in the rules for the inspection of safety appliances.

16. Q—Is there any other information concerning air brakes, their operation and maintenance that it is important that inspectors become familiar with?

Answer—Yes. The air brake rules, which treat on the details of this subject, contain important information that each inspector should become familiar with.

17. Q—What piston travel should be maintained on car equipment?

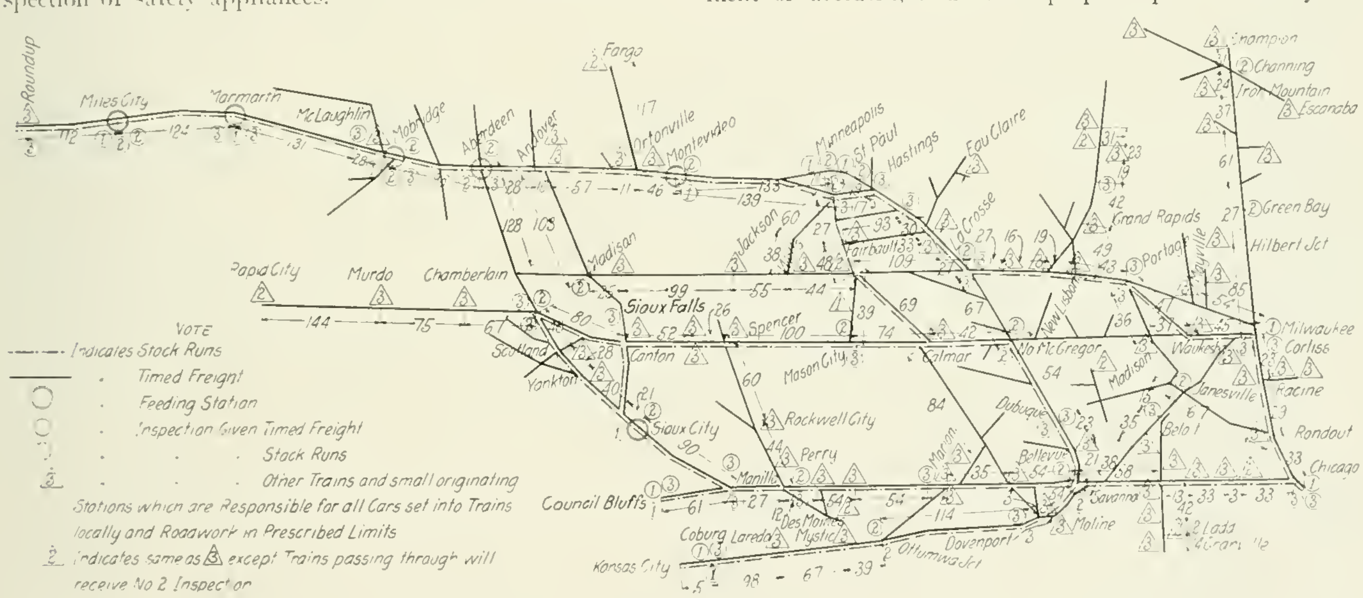
Answer—On cars equipped with automatic slack adjusters it should not be less than 7 in. nor more than 8 in. when the car is standing.* When brakes are applied on cars not equipped with automatic slack adjusters the piston travel must be from 5 in. to 7 in., and in adjusting piston travel it should be 6 in., as per rules and regulations governing air brakes and air signals.

18. Q—What is the underlying idea or principle of the Master Car Builders' Association rules?

Answer—To facilitate the interchange of cars; to establish uniformity of practice in inspecting and repairing them, and in rendering bills for such repairs. Also to make car owners responsible for and chargeable with repairs to their cars necessitated by ordinary wear and tear in fair service.

19. Q—When is a company operating the cars of another company responsible for defects on such cars?

Answer—When the defects are due to unfair usage, derailment or accident, and for improper repairs made by it to



The Lines of the Chicago, Milwaukee & St. Paul, Showing the Through Freight Runs and the Class of Inspection Division Points

14. Q—Why is it essential that journal boxes, journal bearings, axles and lubrication be maintained in good condition?

Answer—To prevent failures of such parts in service and the expense and delay to cars and freight on account of setting out cars on the line for repairs.

15. Q—What attention should inspectors give to air brakes?

Answer—They should see that the air hose, pipes and other parts are maintained in such condition as to keep the brakes in good operative condition; that the brake cylinders, triple valves, high speed reducing valves, slack adjusters, safety valves and dirt collectors are cleaned on all cars, as provided for in the Master Car Builders' Association Code of Rules or other existing instructions.

Supplementary reservoirs on passenger train cars equipped with the LN brake equipment must be cut in when such cars are in passenger trains, but supplementary reservoirs must be cut-out when passenger train cars equipped with the LN equipment are put in freight trains.

such cars; also for certain other improper repairs, which are provided for in the M. C. B. rules.

20. Q—What cars must be accepted in interchange?

Answer—All cars that are in safe and serviceable condition that are free from any safety appliance defect and otherwise meet the requirements of the M. C. B. rules.

21. Q—Who is to be the judge of the safe and serviceable condition of cars offered in interchange?

Answer—The receiving road in all cases not specifically provided for in the M. C. B. rules.

22. Q—Under what condition would you, as delivering inspector, issue an M. C. B. defect card?

Answer—When the company which I represent is responsible for defects according to the M. C. B. rules for which a card is requested.

23. Q—Under what condition would you refuse to issue a defect card?

Answer—If the owner of the car is responsible under the

*This is added as a word of caution when passenger train cars are employed in freight train service.

M. C. B. rules for the defects for which the card is requested to cover.

24. Q—When should a bad-order card be attached to a car?

Answer—In every instance that the car or lading is found to be defective.

CARS AT ORIGINATING POINTS.

(Referring principally to stations, Chicago, Milwaukee, Omaha, Kansas City, Coburg, Council Bluffs, Minneapolis, St. Paul, South St. Paul, Aberdeen, Mitchell, Sioux City, Rapid City, Mobridge, Spokane, Seattle, Tacoma and all originating stations.)

A daily inspection should be made of every freight car standing in yards, industry tracks or at loading stations at all points on the railroad where carmen are stationed. Where conditions will permit, each inspector should be assigned to a particular part of this work. Defects discovered should be either repaired at once or so marked that they will be readily noted by car repairers or box packers, in cases where car inspectors cannot handle the work due to local conditions. The maximum time trains may be held for Class No. 1 inspection is five hours, less time when possible. Cars are to be set out if the work cannot be completed in this period, provided it is desired to move the train. The following will be some of the work necessary in placing trains in proper condition at No. 1 stations:

CLASS 1 INSPECTION.

Class No. 1 inspection, otherwise known as originating or initial inspection and repairs to equipment coming empty or loaded to our lines, also covering the necessary action on loaded equipment before leaving the initial point of loading.

The greatest responsibility we hold as a department is with respect to seeing that we have as nearly a perfect car for any particular lading or routing over our lines as possible, and also to see that the load is so placed in the car by the consignor that it does not cause damage to the car or itself, thereby co-operating to the extent of having the shipment and equipment reach its destination and the consignee in the condition and time that it should, thus overcoming unnecessary expenditures and complaints from shippers. For this reason there must be the very closest co-operation between all employees of this department and those who are placing the loads in the car, both at freight houses, industrial plants and all other similar loading points, to see that the M. C. B. rules are strictly observed, both in open and closed cars, to protect the lading en route against shifting and otherwise, and also on double and triple loads, to see that they are carefully built up to insure safe movement in line with current M. C. B. loading rules. These rules, as in effect, are revised from year to year and are perfected to cover the interchange of equipment throughout the country.

It is important to remember to give close attention to the

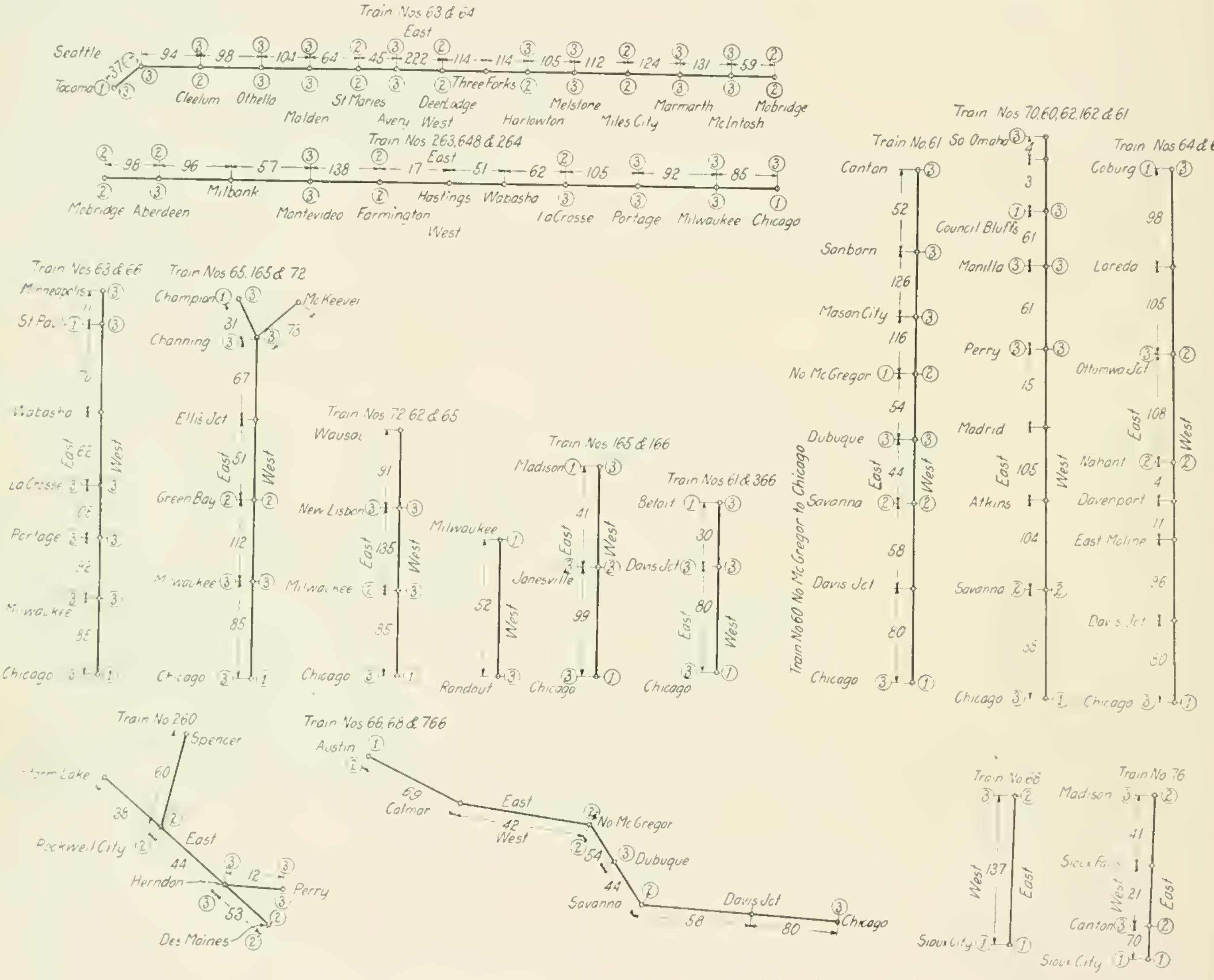
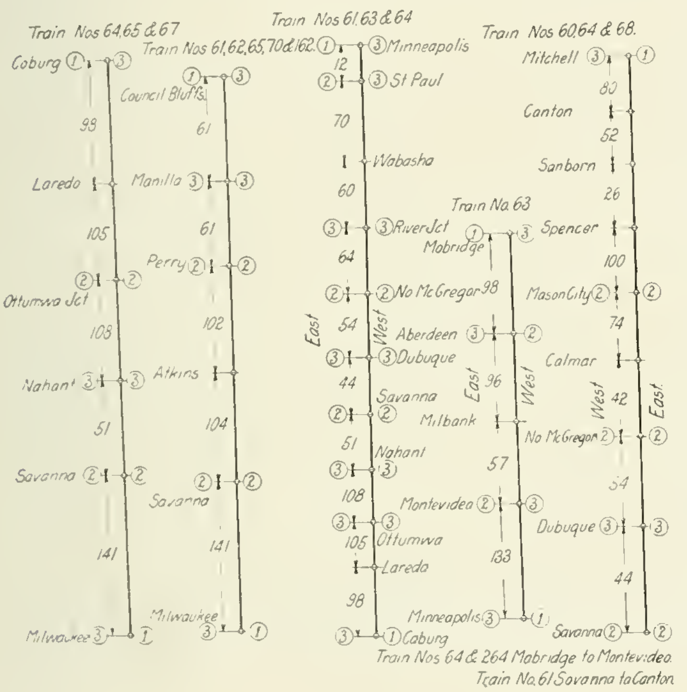


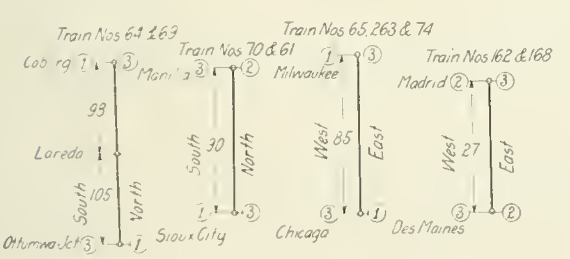
Diagram of Through Freight Trains Showing Provision for Inspection

necessity of providing proper doorway protection and blocking on house cars to overcome damage to the lading and injury at the doorway en route.

Granting that all of the previous requirements have been complied with, the car is accepted for train service to its destination and should proceed without serious difficulty. Primarily intermediate inspection is intended for the purpose of a protection on defects occurring through unfair service that impair the strength or serviceability of the car.

There would, naturally, seem to be little use for intermediate inspection, but when taken collectively the division of our railroad centers are so distributed that when the equipment reaches these intermediate terminals it has covered approximately from 150 to 300 miles, and the service demands an examination of the running gear, a re-examina-





tion and repair of all air brakes and care and attention to lubrication and packing, which as a rule is handled in about three to five minutes to a car.

Method to be Followed in Making Initial Inspection.

The inspectors on the string as it reaches the receiving yard are two ground men, one roof man and two following-up men, and, where the interchange demands it, the same number starting from each end of the string, except the roof man. At this time inspection is made for all handling line defects under existing requirements, repairing all yard defects, such as nuts on box bolts, carry irons, column bolts, draft gear attachments, also brake connection bolts and cotters, brake shoes and keys, brake hangers and parts, and all connections of the hand-brake attachments. In many cases applying brake beams in the train yard is necessary in order to overcome switching any car to the shop track unless absolutely necessary. The finish of the string is then taken for switching and advanced to the receiving yard as a rule, where the air brake test, repairing and box packing is covered. The disposition of through business under such arrangements can be based on the interchange of 8,000 loads and 3,000 empties every 24 hours, with an average of one car out of ten as a cripple to the repair track. This indicates why a plea is made for better equipment at the initial point of loading to overcome serious delays that must be faced en route if such action is not taken, and which is kept constantly before us by the transportation department.

Class 2 Inspection.

Class No. 2 inspection, otherwise termed as that attention given cars passing from one grand division to another or having operated 300 to 500 miles without previously having had either No. 1 or No. 2 inspection.

This class of inspection contemplates suitable attention being given cars at certain definitely assigned divisional points and small originating and interchange stations. Under this classification wheels and axles should be given careful inspection. Brake shoes having a reddish color indicate that there has been a long application of the brakes which heat the wheels, and the latter should be carefully examined for cracks in the plates. Box lids should be opened and the condition of the lubrication and journals ascertained. Any bearing showing an indication of heating should receive the necessary attention.

Draft gear and couplers should be examined for the purpose of detecting defects that may have come into existence. Safety appliances must be repaired when found defective.

Brake beams and connections should be examined to see that they are up and in proper and safe condition. Brakes should be tested by the incoming engine making a 20-lb. reduction from a 70-lb. train line pressure and the brakes left set while the inspection is being made. The condition of truck sides and arch bars should also be observed and all missing nuts replaced and loose nuts tightened up.

Inspectors should so locate themselves in the yard that the train will pass them, when entering their respective yard, with a view of discovering loose and defective wheels and brake gear.

Class 3 Inspection.

Class No. 3 inspection, otherwise termed as that attention given equipment coming into a terminal and having recently received a No. 2 inspection at least within a distance of 300 miles and where engines are changed.

Inspectors should locate themselves in their respective yards so as to have the entire train pass them, observing closely and providing remedy for pounding wheels, brake beams and connections down or loose, hot bearings, defective draft attachments and related parts and violations of federal safety appliance requirements. After defects that were discovered on the train have been remedied, inspectors must proceed to make further inspection if time will permit.

Inspectors Located at Isolated Stations and Large Manufacturing Plants.

There are many points on the system, especially at large terminals, such as the Dearing plant of the International Harvester Company at Chicago; Montgomery Ward & Co., Chicago; Solvay Coke Plant at Milwaukee; the Washburn-Crosby Co. at Minneapolis; packing plants at Sioux City, Omaha, St. Paul, Spokane; cereal mills at Cedar Rapids, etc., where high class competitive freight is loaded and received. Cars are made empty and unless carefully watched are apt to be reloaded out on our line in defective condition, due to defective running gear or improper body construction for loading with some other commodity, both opening an avenue to damage claims and excessive delay en route.

Adequate words could not be found in praise of car inspectors who do their whole duty at points like these, where

they are away from any immediate supervision, and can assist so greatly to see that only proper cars for any specified loading are allowed to be considered for outbound movement over the railroad, and where improper methods are followed in the use of or delivery of cars, either loaded or empty, that instant report is given so that proper precautions can be taken and the remedy applied. Cars being delivered loaded when found defective on account of no door protection being provided, in accordance with M. C. B. rules, or where cars marked for rough freight are delivered on request for merchandise cars or otherwise, or any other irregularities coming to notice day by day, should never be dropped until someone has seen to it that lax methods are avoided and stopped. In order to carry such a plan out it is always well for car inspectors to commence the day by going over all cars to note especially those fit for loading, marking out any which cannot satisfactorily be loaded, assigning the various grades of equipment to meet requirements, having in mind the territory on the system where they are to be made empty, and using good judgment in assuming that they must make a round trip at least so far as their physical condition is concerned, and also that they will be fit to carry a full return load of such commodities as originate in the territory from which they are to return. It is also well to remember when desirable to get cars to home connections full knowledge of the character and direction of the prevailing loading is necessary, so that proper loaded movement may result. In carrying out the actual work on cars handled, it is well to do the inside work first, then go over the draft gear, brakes, roof, safety appliances, trucks and packing in the order named. The remarks made herein also apply equally to one-man stations at outlying points along the railroad. There is always more or less shortage of equipment, especially the better grade of cars, and where such equipment is being misused through loading with rubbish or otherwise, report must be made and the practice stopped.

(To be continued.)

BUREAU OF EXPLOSIVES PAMPHLETS

Two pamphlets, Nos. 20-I and 20-J, have recently been issued to wreck crews and car inspectors respectively by the Bureau of Explosives. Copies of the pamphlet follow and the full text of the regulations, from which the instructions are compiled, can be referred to readily by means of the reference to the Rules of the Bureau of Explosives at the end of each paragraph.

INSTRUCTIONS TO WORK CREWS.

Prevent fires at wrecks.—The most important point in handling wrecks is to prevent fires, especially if explosives or inflammables are involved. (1697, 1946.)

Remove explosives to a safe place.—All explosives, including broken packages, should be removed to a safe place, before beginning to clear a wreck. (1697.)

Prevent sparks in using tools, etc.—Every precaution must be used to prevent sparks when using tools, crane or locomotive to clear wreck. (1697.)

Saturate explosives remaining on ground.—Where probability of explosives remaining on the ground or in the wreck exists it should be saturated thoroughly with water. (1697.)

Handle dynamite with extra care.—Water on dynamites will not make it safe from shocks or blows, so that it is important that all such explosives be handled with extra care, even if wet. (1697.)

Handling fulminates in wrecks.—Mixing with wet earth makes all explosives safer to handle. In case fulminate has been scattered by a wreck, after the wreck has been cleared the wet surface of the ground should be removed and the area saturated with fuel or lubricating oil and then covered with fresh earth. (1697.)

Keep lighted lanterns away from inflammable freight.—It is assumed that wrecks always contain leaking and damaged packages and lighted lanterns or other flames should not be taken into or near cars containing inflammable freight. (1946.)

Ventilate all cars containing inflammable freight.—All cars containing inflammable freight must be opened for ventilation and all packages protected by red labels and all cylinders of compressed gases removed to a safe place. (1,-946.)

Remove yellow labeled substances.—All substances spilled from broken packages protected by yellow labels should be removed to a safe place. (1946.)

Cover inflammable liquids with dry earth.—All inflammable liquids spilled from broken packages or tank cars must be covered with dry earth before a lighted lantern, torch, or an engine is used in the vicinity. (1946.)

Handling spilled acids.—When acids are spilled in cars the floors should be covered with dry earth, swept clean and flushed with water. (1946.)

Use judgment to avoid fires.—Good judgment is necessary to avoid fires and useless sacrifice of property. (1951.)

Handle oil cars in daytime or use electric lights.—Dispense with all naked lights or fires possible when oil cars are leaking. Handle wrecked oil cars during daylight hours or use electric incandescent lights or electric flashlights. (1952.)

Keep lanterns on side from which wind is blowing.—When handling leaking tank cars having "inflammable" placards keep lanterns used for signalling on side from which wind is blowing and as high in air as possible, and keep lighted pipes, cigars and cigarettes away. The ash pan and firebox of a locomotive or steam derrick is also a source of danger. (1953.)

Drain leaking oil to prevent spreading.—Prevent the spread of oil by collecting it in any available vessels or draining it into a hole at a safe distance from track. Do not drain into sewers or streams of water. A stream of oil on the ground should be dammed and dry earth be thrown on the liquid as it collects. (1954.)

Do not drag wrecked tank cars.—Wrecked tank cars should be carefully jacked into position and should not be moved by dragging except as a last resort. All shocks and jars that might produce sparks or friction should be avoided. (1955.)

Handling leaking tank cars.—Do not transport leaking tank cars unnecessarily. Safety in short movements may be secured by attaching a vessel under small leaks. Cover tracks with fresh earth in rear to prevent fire overtaking car. Allow no smoking and keep engines away. If traffic is not obstructed contents of leaking tank cars should be transferred. (1956.)

Keep lights away from empty tank cars.—Keep lights away from empty or partially empty tank cars. (1957.)

Do not use water to quench oil fires.—When oil catches fire it should be smothered if possible by the use of earth, steam or wet blankets. Water will not quench an oil fire. (1958.)

Leaks at bottom outlet valves.—Leaks at unloading valves may possibly be stopped by removing the dome cover on top of tank and by moving the valve-rod handle in the dome back and forth a few times. (1959.)

Dome covers must not be removed while pressure exists.—Do not remove dome covers of tank cars containing inflammable liquids until satisfied, by lifting safety valve, that no pressure exists in tank. (1959.)

Keep trespassers away.—Guards should be placed to keep trespassers at a safe distance. (1955, 1956.)

SUGGESTIONS TO CAR INSPECTORS

Special inspection of cars necessary before loading explosives.—Certified cars to be used for explosives, must be carefully inspected inside and outside to see that the roof and sides have no loose boards, holes, or cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the king bolts or draft bolts are properly protected, and that there are no uncovered iron or nails projecting from the floor or sides of the car which might injure packages of explosives; also that the floor is in good condition and has been cleanly swept before the car is loaded and that the journal boxes have been examined and that they are properly covered, packed and oiled, and that the air brakes and hand-brakes are in condition for service. (1661, 1662.)

Car certificates necessary.—Car certificates certifying to the proper condition of the car must be executed in triplicate by the car inspector. (1665.)

Inspection of explosives from connecting lines required.—Certified cars, containing explosives, when offered in interchange, must be carefully inspected by the receiving line and must not be forwarded until all violations have been corrected. Lading should also be inspected if practicable and it must be inspected when the car shows evidence of rough treatment. Only electric lights should be used when inspection is made after daylight hours. (1654.)

Company material not exempt.—Company material and supplies must be handled in accordance with the regulations. (1404, 1704.)

Inspect explosive cars frequently, and give notice if set out.—Cars containing explosives must be inspected at every opportunity to guard against hot boxes or other defects. When set out short of destination notice must be given, and all precautions taken to guard against accidents. (1690.)

Stenciling on tank cars necessary.—Tank cars must comply with M. C. B. specifications and must be stenciled to show such compliance. When not so stenciled, or if leaking, or any defects that would make leakage during transit probable, they must not be used for the transportation of any of the inflammable liquids. (1822-d.)

Inspection of loaded tank cars.—Loaded tank cars tendered for shipment must be inspected by the carrier to see that they are not leaking; tanks must be loaded with outlet valve caps off, and it is recommended that these caps be allowed to remain off until the car inspector passes on the car. Outlet valves must not permit more than a dropping of the liquid with the valve caps off. The inspector must also see that air and hand-brakes, journal boxes, trucks and safety appliances are in proper condition before accepting the car. (1822-c, f.)

Safety valves on tank cars.—Safety valves on tank cars used for the shipment of inflammable liquids whose flash-point is below 20 deg. F. must be set to operate at 25 lb. per sq. in., and the tank must be stenciled to show the pressure and date of test. (M. C. B. Rules; 1822-g, 1824-j.)

Dome placards.—The shipper must attach to the dome of all tank cars loaded with casing head or absorption gasoline, blended or unblended, three special white dome placards, one on each side of the dome and one on the dome cover. These cars also require four inflammable placards. (1824-k.)

Keep lights away from empty tank cars.—Lighted lanterns or other naked lights must not be used to examine the interior of empty tank cars. Only incandescent electric lights should be used for this examination. (1903-b.)

Dome covers and valve caps required on empty tank cars.—Empty tank cars should not be moved unless outlet valve caps and dome covers are securely placed in the proper position. (1903-c.)

Inflammable liquids permitted in ordinary tank cars.—Gasoline, casing head gasoline, or any other inflammable liquids with flash points lower than 20 deg. F. may be shipped in ordinary tank cars that have been tested with cold-water pressure of 60 lb. per sq. in., and so stenciled, provided that the vapor tension of the liquid does not exceed 10 lb. per sq. in. (1824-j.)

Description of casing head products.—Casing head gasoline may be described as gasoline, casing head gasoline or casing head naptha when the vapor pressure does not exceed 10 lb. per sq. in., but when the vapor pressure exceeds 10 lb. per sq. in. it must be described as liquified petroleum gas. (1824-k.)

Liquified petroleum gas permitted in insulated tank cars.—Liquid petroleum gas of vapor pressure, not exceeding 15 lb. from April 1 to October 1, and 20 lb. from October 1 to April 1, when shipped in tank cars must be shipped in special insaluted tank cars approved by the M. C. B. Association. (1824-k.)

Guard against hot journals on inflammable cars.—Cars bearing "inflammable" placards and cars adjacent to them must be watched with extra care to discover hot journals, and every possible precaution taken to avoid igniting vapors when leakage is discovered. (1908.)

Stop leaking tank cars and keep lights away.—All unnecessary movement of tank cars discovered leaking in transit loaded with an inflammable or corrosive liquid must be stopped, and the unsafe condition corrected. Lanterns or other naked lights must be kept away from cars protected with inflammable placards and on the side from which the wind is blowing and as high in the air as possible. Electric lights should be used whenever practicable. Good judgment is necessary to avoid fires and useless sacrifice of property. (1909, 1951, 1953.)

Handle oil cars in daytime or use electric lights.—Naked lights or fires should not be used when oil cars are leaking. Wrecked oil cars should be handled during daylight hours, or electric incandescent lights, or portable electric flashlights used. (1952.)

Drain leaking oil to prevent spreading.—To prevent the spread of oil, it should be collected in any available vessels or drained into a hole at a safe distance from the track. It should not be drained into sewers or streams of water. A stream of oil on the ground should be dammed and dry earth thrown on the liquid as it collects. (1954.)

Do not drag wrecked tank cars.—Wrecked tank cars should be carefully jacked into position and should not be moved by dragging, except as a last resort, and all shocks and jars that might produce sparks or friction should be avoided. (1955.)

Handling leaking tank cars.—Leaking tank cars should not be moved unnecessarily. Safety in short movements may be secured by attaching a vessel under small leaks. Covering the tracks with fresh earth in rear will prevent the fire from overtaking the car. No smoking should be allowed and engine must be kept away. If traffic is not obstructed contents of leaking tank cars should be transferred. (1956.)

Keep lights away from empty tank cars.—Lights must be kept away from empty or partially empty tank cars or any care bearing inflammable placards. (1957, 1908-b.)

Do not use water to quench oil fires.—When oil catches fire it should be smothered if possible by the use of earth, steam or wet blankets, as water will not quench an oil fire. (1958.)

Leaks at bottom outlet valves.—Leaks at unloading valves may be stopped by removing the dome cover on top of the tank and by moving the valve-rod handle in the dome back and forth a few times. (1959.)

Release pressure before removing dome covers.—Dome covers of tank cars containing inflammable liquids should not be removed until no pressure exists in the tank, which should be ascertained by lifting safety valves. (1959.)

Stop "blowing" safety valves by cooling shell.—When the "blowing" of safety valves of a tank car is noted the car should be sprayed with water or any other possible means of cooling the shell of the tank should be used. (1912-d.)

Keep trespassers away.—Unauthorized persons must be kept away from explosives and other dangerous articles. (1643-b, 1871-d.)

Report violations.—Violations of the rules, such as defects of cars containing explosives, tank cars that do not comply with M. B. C. Rules or other requirements, etc., must be reported. (1434-a, 1715-a.)

Annual Report of the Bureau of Safety

Use of Hand Brakes on Heavy Grades Condemned; Automatic Stops and Train Pipe Connectors Tested

The report of the chief of the Bureau of Safety, which was recently issued is of particular interest this year, as it contains, in addition to the usual review of the safety appliance inspection work, important recommendations regarding air-brake maintenance and the operation of trains on heavy grades. The following is an abstract of the portions of the report dealing with these questions.

The table below affords opportunity for ready comparison of the results of inspections with previous years. It has been compiled from the principal figures for the fiscal years ended June 30, from 1915 to 1919, inclusive:

	1915	1916	1917	1918	1919
Freight cars inspected	1,000,210	908,566	1,100.104	1,059,913	1,023,942
Per cent defective...	4.77	3.72	3.64	3.92	3.7
Passenger cars inspected	33,427	27.220	29.456	25,732	23.712
Per cent defective....	2.85	1.82	0.85	0.56	0.39
Locomotives inspected.	38.784	31,721	37,199	33.806	30.707
Per cent defective....	4.06	3.66	2.69	2.18	1.84
Number of defects per 1,000 inspected	27.23	45.56	41.16	44.01	40.92

As shown by this summary, there was a decrease for the past year in the percentage of defects found on all classes of equipment inspected, namely, freight cars, passenger cars and locomotives; the number of defects per 1,000 cars and locomotives inspected is the lowest in the history of safety appliance inspection. For the past five years this percentage has been maintained at a low figure, but nevertheless the reports for the last fiscal year indicate a marked improvement in the general condition of safety appliance equipment.

An analysis of the figures, however, shows that of a total of 44,129 defects, comprising 244 distinct classes of defects, 22,275 were defects to visible parts of air brake apparatus, and of these 20,283 represent but 5 classes, viz.: air brake cut out, 7,124; cylinder and triple not cleaned within 12 months, 6,258; train pipe loose, 1,802; release rod missing, 3,258; and retaining pipe defective, 1,841. In other words, more than half of the total number of defects reported during the year were due to defective air brakes, 91 per cent of which were confined to five visible parts. It is apparent, therefore, that it is entirely practicable to effect a material improvement in the condition of safety appliance equipment. The remedy for this condition lies in more thorough inspection by the carriers themselves and prompt repair of defective equipment. Inasmuch as only a small percentage of cars and locomotives in service remains to be equipped in accordance with the safety appliance standards prescribed by the commission's order of March 13, 1911, the carriers will be in position to devote greater effort toward maintaining safety appliances in proper condition, and in future years still further decrease in the percentage of defects is confidently expected.

In the investigation of the condition of air brakes on trains as they left terminals after terminal or standing tests have been made by the commission's inspectors Tests of 1,196 trains were made, aggregating 41,846 cars. In these trains there were but six non-air cars; there were 330 cars with their brakes cut out, and 1,947 on which the brakes did not apply; in the trains tested, the brakes were operative on an average of 93 per cent of the cars.

During the year, evidence of violations of the safety appliance laws by railroads operated under federal control has not been filed with United States district attorneys for prosecution, but such evidence has been furnished to the United States Railroad Administration to enable it to take corrective measures. In connection with the consolidation and unification of terminal facilities effected by the Railroad Administration, investigations conducted by this bureau have disclosed that in some instances proper inspection was not being given equipment in such terminals, and available repair facilities were not being sufficiently utilized to insure that cars having safety appliance defects would not be moved in violation of law. Several cases of this character were called to the attention of the Railroad Administration, and in each case, sometimes after conferences between representatives of this bureau and the railroad companies involved, proper corrective measures were taken so as to secure compliance with the requirements of law. The Railroad Administration has co-operated with this bureau to the fullest extent, to the end that safety appliance conditions be improved, and that the requirements of the safety appliance law be fully observed, and a marked increase during the year in the effectiveness of the administration of the safety appliance law has resulted.

Notwithstanding the requirement of law that trains must be controlled by power brakes without the use of hand brakes for that purpose, situations exist on several railroads in different parts of the country where trains are still controlled on mountain grades by means of hand brakes. Measures are being taken by this bureau, with the co-operation of the Railroad Administration, to bring about the discontinuance of this practice and to secure full compliance with the law. In some cases of this character, joint investigations have been conducted by this bureau and the railroad companies involved for the purpose of fully establishing what the present operating conditions are and what facilities are available for inspecting, testing, and repairing air-brake equipment. Demonstrations have then been conducted to show that it is both practicable and safe to control trains on these grades by means of power brakes, as required by law. These demonstrations consist of placing air-brake equipment on a number of trains in proper operating condition, and then operating these trains down the mountain grades in question, controlling the speed solely by the use of power brakes. In each case, a sufficient number of demonstrations of this character have been conducted to satisfy fully all concerned that operating practices conforming to the requirements of the law are feasible, and measures have then been taken by the Railroad Administration to place these practices in effect. Investigations and demonstrations of this character have already been conducted on the Baltimore & Ohio and

the Philadelphia & Reading, and investigations of operating practices on mountain grades of other railroads are now in progress. The investigations made have demonstrated that all that has been necessary was proper maintenance of air-brake equipment, as well as instruction and education of railroad employees in its proper use under the conditions existing on such grades.

These instances, together with the results of safety-appliance inspections during the past year, again direct attention to the fact that improvement in the condition of air-brake equipment and in air-brake operating conditions is one of the urgent demands of railroad service at the present time.

The order of the Commission of June 6, 1910, requires:

That on and after September 1, 1910, on all railroads used in interstate commerce, whenever, as required by the safety appliance act as amended March 2, 1903, any train is operated with power or train brakes, not less than 85 per cent of the cars of such train shall have their brakes used and operated by the engineer of the locomotive drawing such train, and all power brake cars in every such train which are associated together with the 85 per cent shall have their brakes so used and operated.

The minimum percentage requirement established by this order is generally understood and recognized, and it is an infrequent occurrence that a train is hauled from a terminal having less than 85 per cent of the cars equipped with power brakes in operative condition. However, in addition to the minimum percentage requirement specified, the order also reiterates the provision of law that all power-brake cars in a train which are associated together with the specified minimum percentage shall have their brakes used and operated. Railroad companies have paid comparatively little attention to this maximum requirement of the law and order, and the belief is widespread and general that if a train has the prescribed minimum percentage of power-brake cars with air brakes in operation, the terms of the law are fully complied with. It is common practice at the present time for trains to leave terminals having some cars with inoperative brakes, or having brakes cut out, notwithstanding the fact that facilities are available at such terminals for making repairs or replacements necessary to place all power-brake equipment in proper operative condition.

Strict enforcement of the provision that "all power-brake cars in every such train which are associated together with the 85 per cent shall have their brakes so used and operated," as applied to trains leaving terminals or other points where facilities for making repairs are available, would result in 100 per cent operative power brakes in practically all trains leaving such points. The adoption of this practice would inevitably result in general and material improvement in air-brake conditions, as careful and thorough air-brake tests at terminals would be required as well as that more prompt attention be given necessary air-brake repairs. It would also result in reducing the number of violations of the minimum percentage requirement, for the reason that frequently trains now leave terminals with barely 85 per cent of the cars having power brakes in operative condition, and if the brake equipment on additional cars becomes defective en route, or if cars with defective brakes are picked up, or if cars with good brakes are set out, the train then has less than the required 85 per cent.

The adoption of this policy would go far toward meeting the complaint referred to in the last annual report, which is still frequently heard, that air-brake maintenance is neglected on roads where braking conditions are less severe than on roads having steep mountain grades, thereby imposing an excessive burden on the air-brake inspection and repair forces of the latter roads.

As stated in the annual report of this bureau for last year, notwithstanding the adverse decision of the Circuit Court of Appeals for the Fourth Circuit in the Chesapeake & Ohio case, it is believed that a proper interpretation of the law requires that the air brakes of all cars in every train which have been equipped with power brakes, as distinguished from non-air cars, and which are associated with cars having operative power brakes, must be in operative condition and must be used by the engineer of the locomotive drawing the train. The ground upon which the minimum percentage was prescribed was that there were numerous cars in service which had not been equipped with power brakes, and provision should be made for continuing them in service until they could be equipped. It is clearly evident that the maximum requirement of the law and the Commission's order is a progressive one, making it obligatory upon the carriers to use air brakes in an increasing ratio until all cars are equipped; and the provisions are mandatory that when all cars in train are equipped with power brakes, all such brakes must be used by the engineman of the locomotive hauling the train.

In addition to terminal tests of trains made up for departure, more general adoption of the practice of conducting air brake tests on trains when arriving at terminals is also advocated. Incoming tests of this character disclose the condition of air-brake equipment in time to permit of necessary repairs and adjustments being made without delaying trains made up and ready for departure, as well as eliminating switching for the purpose of setting out cars with defective brakes.

The air-brake provision of the law has again been passed upon by the Supreme Court of the United States in the case of Louisville & Jeffersonville Bridge Co. *v.* United States, involving the movement of transfer trains from one yard to another, crossing city streets at grade and using the main-line track for a distance of at least 2,600 feet, without the specified minimum percentage of power brakes being in use. In this case the court stated that it would be difficult to imagine a movement in which the control of the cars by train brakes would be more necessary, notwithstanding that the street crossings were protected by gates and the main-line movements were watched over by a yardmaster from an elevated tower. It was also stated that the absolute duty to comply with the law is not excused by carefulness to avoid the danger which the appliances prescribed were intended to guard against, nor by the adoption of what might be considered equivalents of the requirements of the act.

This same provision has also been interpreted by the Circuit Court of Appeals for the Fifth Circuit in two cases involving the movement of tranfser trains in and about the city of Galveston for several miles, crossing main-line tracks of several railroads and streets at grade, and for parts of the distance over main-line track as well as a network of tracks comprising the city yards, without the specified minimum percentage of power brakes being in use. It was held that the movements in question were not switching operations, but train operations to which the law applies. It was also held that the fact that there were switching operations before the movements were completed did not have the effect of making the entire movements such as do not come within the prohibition of the statute.

INVESTIGATION OF SAFETY DEVICES.

During the year plans of 80 devices were submitted for consideration; 74 devices were examined and opinions thereon transmitted to the proprietors. Of the number examined, 57 were so impracticable or crude that they were considered practically worthless; seven were devices which were not intended primarily to promote safety in railway operation, and 10 possessed elements of merit which warranted further development or practical tests to prove their utility. In addition, revised plans of 15 devices which had been previously examined were submitted for further consideration, and all of these plans were examined and reported upon; four of these latter devices were commended to the extent

of warranting further development or trials under service conditions. Among the devices upon which favorable reports were made, there were eight automatic train-control devices, five brake devices or attachments and one railroad tie.

During the year tests were conducted of the automatic train-control system submitted by the National Safety Appliance Company, San Francisco, Cal. This device is of the magnetic induction type employing permanent magnets in both track and locomotive equipment, as well as an electromagnet on the track for nullifying or neutralizing, when desired, the effect of the permanent track magnet. Tests were made on the Western Pacific and the Southern Pacific Railroads from March to June, 1919, and a report upon this device was transmitted to Congress by the Commission under date of June 30, 1919, this report being printed as House Document No. 139, Sixty-sixth Congress first session. The following conclusion is stated in that report:

While as a whole the tests made are not considered conclusive, it has been demonstrated that, with the exception of one of the locomotive-control valves used in the tests, the locomotive apparatus, so far as could be determined, operated as intended, and whenever actuated by the track-magnet impulse it accomplished the functions for which it was designed; further, that the transmission of a magnetic impulse from a permanent magnet installed on the track to locomotive apparatus designed to be controlled and actuated thereby is both practical and feasible. The fundamental principles upon which this system is based have therefore been demonstrated to be sound and practicable, but the available working limits, as well as the reliability of the transmission and control of the actuating impulse, remain to be fully established. For these purposes further development work, as well as more extended trials under practical service conditions, is necessary.

Tests have also been conducted of the automatic train-pipe connector submitted by the American Connector Company, Cleveland, Ohio. This device is in use on the Copper Range and tests were made in July and August. A report upon this device was transmitted to Congress by the commission. The conclusion stated in this report is that the use of this automatic connector on the Copper Range materially reduces the hazards to which trainmen are subjected as it almost entirely eliminates the necessity for men to go between the cars of connector-equipped trains. The device tested possessed some features which were not fully applicable to general railroad operating conditions, but the results of the tests and its use on that road warrant its further development for the purpose of more fully meeting the requirements of an automatic train-pipe connector for general railroad service.

Comparative Tests of Refrigerator Cars

Temperature Readings in Actual Service on Cars Equipped with Overhead and End Ice Bunkers

The object of this test was to investigate the comparative refrigerating performance of a car equipped with overhead ice tanks and one equipped with collapsible end ice tanks. Both cars were pre-iced and loaded with Tokay grapes and were handled under standard refrigeration from Lodi, Cal., to Chicago, Ill.

The equipment used in the test consisted of Santa Fe refrigerator car SFRD 12646 and Chicago Great Western refrigerator car 30000. SFRD 12646, Class U, was built in the winter of 1917-18, and is equipped with Santa Fe standard collapsible bulkheads (Bohn Syphon) without floor racks. Car GGW 30000 was built in the fall of 1915, and in the spring of 1919 it was reinsulated to make the insulation two inches thick, the same thickness as SFRD 12646. During the summer of 1919 the ice tanks, baffle and drains of car CWG 30000 were reconstructed for experimental purposes. This car was taken for the test before final permanent construction of the hatches, tanks and baffle had been made in order that the test could be conducted this season. The results of the test as regards temperature, air circulation and refrigeration would not be affected by this temporary installation. Car GGW 30000 is equipped with six overhead basket ice tanks of the Moore type and with floor racks.

The following table shows the principal dimensions of the two cars under test:

	CGW 30000	SFRD 12646
Loading capacity	60,000	60,000
Outside length	40 ft.	41 ft. 3 in.
Inside dimensions		
Length	37 ft. 10⅝ in.	33 ft. 2¼ in.
Width	8 ft. 2 in.	8 ft. 2¾ in.
Height floor to ceiling	7 ft. 8⅛ in.	7 ft. 3 in.
Height racks to ceiling	7 ft. 3⅜ in.	....
Height racks to ice tank	5 ft. 11 13/16 in.	....
Ice tank		
Kind	Overhead	Basket End Collapsible
Ice capacity	6,300	10,500
Bulkheads	4¾ in. False ends	Bohn Syphon
Insulation, thickness	2 in.	2 in.

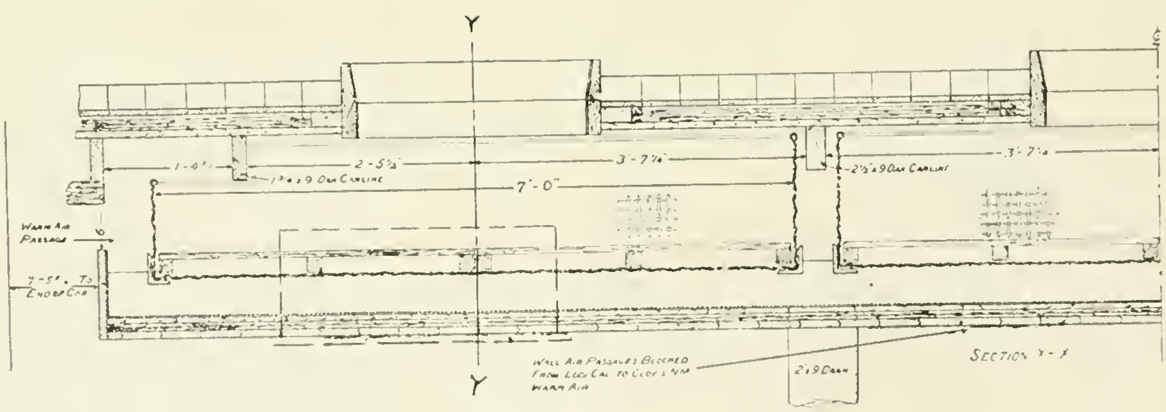


Fig. 1. Longitudinal Section Through Ice Tanks of C. G. W.-30,000

TABLE I—COMPARISON OF TEMPERATURES, IDENTICAL LOCATIONS, CARS, GRAPES UNDER REFRIGERATION, SFRD 12646 vs. CGW 30000

Location	Therm. No. 3 CGW 30000	Therm. No. 3 SFRD 12646	Therm. No. 4 CGW 30000	Therm. No. 4 SFRD 12646	Therm. No. 5 CGW 30000	Therm. No. 5 SFRD 12646	Therm. No. 6 CGW 30000	Therm. No. 6 SFRD 12646	Therm. No. 7 CGW 30000	Therm. No. 7 SFRD 12646	Therm. No. 8 CGW 30000	Therm. No. 8 SFRD 12646
Lodi, Cal.	58.7	61.3	56.2	54.2	57.3	60.2	57.2	39.3	59.0	59.0	56.4	53.7
Stockton, Cal.	53.4	59.8	54.4	48.0	56.3	59.5	55.7	36.8	57.5	66.2	54.2	42.6
Riverbank, Cal.	50.3	58.6	53.0	46.2	55.8	58.7	54.6	36.1	56.8	57.1	52.7	41.9
Calwa, Cal.	47.7	56.3	51.4	44.4	54.8	57.0	53.2	35.7	55.9	55.6	51.5	39.5
Bakersfield, Cal.	46.1	54.2	49.8	42.8	53.5	55.2	51.5	35.6	54.6	54.1	50.0	38.2
Barstow, Cal.	44.3	51.1	47.7	41.6	52.4	52.7	49.3	34.9	53.0	51.7	47.6	37.5
Needles, Cal.	43.1	49.0	45.9	41.2	50.5	50.7	47.5	35.4	51.2	51.9	45.4	36.8
Needles, Cal.	42.8	48.3	45.3	40.5	50.1	50.5	47.1	35.1	50.8	49.4	46.1	36.7
Needles, Cal.	42.6	48.0	45.2	40.5	49.7	50.3	47.1	35.2	50.5	49.3	46.0	36.6
Kingman, Ariz.	42.0	47.2	44.6	40.3	49.9	49.8	46.8	35.3	50.0	48.4	45.6	36.5
Cherokee, Ariz.	41.8	46.9	44.5	40.3	49.3	49.0	46.6	35.3	49.6	48.0	45.4	36.5
Seligman, Ariz.	41.5	46.6	44.2	40.2	48.5	48.9	46.4	35.4	19.4	47.9	45.4	36.7
Ash Fork, Ariz.	41.7	46.6	44.1	40.2	48.2	48.6	46.2	35.3	49.2	47.8	45.3	36.7
Wiliams, Ariz.	41.6	46.3	44.0	40.1	48.0	48.4	46.1	35.2	49.0	47.6	45.1	36.5
Winslow, Ariz.	41.6	45.9	43.9	40.2	47.9	48.0	45.7	35.2	48.8	47.0	45.0	36.5
Adamana, Ariz.	40.6	45.2	43.5	39.8	47.5	47.3	45.4	34.9	48.1	46.3	44.4	36.4
Gallup, N. M.	40.0	44.5	43.1	39.5	46.9	46.3	44.9	34.9	47.5	45.7	43.8	36.1
Belen, N. M.	39.4	43.7	42.3	39.2	45.9	45.8	44.1	34.8	46.7	45.1	43.1	35.8
Vaughn, N. M.	38.9	42.7	41.8	38.8	45.4	44.9	43.3	34.7	45.9	44.0	42.5	35.6
Glovis, N. M.	39.0	42.6	41.5	38.8	44.9	45.6	43.1	35.7	45.4	44.0	42.3	36.1
Amarillo, Tex.	39.1	43.1	40.9	39.2	44.3	44.9	42.7	35.8	45.0	44.3	41.9	36.2
Canadian, Tex.	38.9	43.2	40.6	39.4	44.0	44.8	42.6	35.8	44.7	44.2	41.8	36.6
Waynoka, Okla.	39.3	43.6	40.6	39.5	43.9	45.4	42.5	35.4	44.6	45.0	41.8	36.3
Wellington, Kan.	38.7	44.3	40.1	39.8	43.6	45.6	42.8	35.2	44.1	45.4	41.5	36.3
Wellington, Kan.	38.0	43.9	40.2	39.7	43.4	45.4	42.1	35.4	44.0	44.9	41.5	36.2
Emporia, Kan.	38.0	43.6	40.0	39.5	43.2	45.0	42.0	35.1	43.6	44.5	41.3	35.9
Argentine, Kan.	37.9	42.8	40.0	39.1	42.7	44.2	41.9	34.9	43.1	43.5	41.3	36.0
Argentine, Kan.	37.7	42.6	39.7	38.7	42.3	43.5	41.5	34.3	43.0	43.2	40.8	35.7
Lexington Jct., Mo.	37.4	42.3	39.5	38.6	42.3	43.7	41.2	34.3	42.7	43.3	40.6	35.4
Shopton, Iowa	37.0	41.7	39.2	37.7	42.0	42.9	40.3	34.2	42.3	42.5	40.0	34.8
Chillicothe, Ill.	36.4	41.6	38.8	37.3	41.7	42.4	39.8	34.0	41.8	42.0	39.4	34.5
Corwith Yards, Chicago	36.0	40.7	38.2	37.2	41.2	42.0	39.4	33.9	41.4	41.7	39.2	34.2
Average	41.6	48.2	43.9	40.7	47.7	48.4	44.1	35.3	46.8	47.6	44.7	37.2

Location	Therm. No. 9 CGW 30000	Therm. No. 9 SFRD 12646	Therm. No. 11 CGW 30000	Therm. No. 11 SFRD 12646	Therm. No. 12 CGW 30000	Therm. No. 12 SFRD 12646	Therm. No. 1 CGW 30000	Therm. No. 1 SFRD 12646	Therm. No. 10 CGW 30000	Therm. No. 10 SFRD 12646	Therm. No. 2 CGW 30000	Therm. No. 2 SFRD 12646
Lodi, Cal.	57.1	58.6	56.6	60.8	58.7	60.5	58.0	51.7	60.0	66.1	55.3	72.6
Stockton, Cal.	57.0	58.7	54.1	53.4	56.4	57.8	49.3	46.2	54.8	56.8	46.7	59.2
Riverbank, Cal.	49.1	57.7	50.8	50.7	52.2	55.8	48.2	45.7	53.9	54.9	46.0	56.4
Calwa, Cal.	47.9	55.9	48.9	48.3	49.6	52.8	47.5	43.9	52.9	52.9	44.6	53.8
Bakersfield, Cal.	46.5	54.7	47.5	46.3	48.4	50.0	45.8	43.3	52.2	53.4	39.6	57.1
Barstow, Cal.	43.9	52.2	45.5	44.7	45.8	48.0	44.1	42.2	50.2	48.9	39.7	50.2
Needles, Cal.	42.9	50.6	44.4	43.3	44.8	45.4	44.5	43.7	49.3	49.5	40.4	53.2
Needles, Cal.	42.5	50.2	44.2	43.0	44.4	44.9	43.8	41.8	49.2	48.8	36.0	51.5
Needles, Cal.	42.3	49.9	44.0	42.9	44.2	44.8	43.7	41.5	48.9	48.4	36.6	50.8
Kingman, Ariz.	41.8	49.2	43.6	42.6	43.8	44.3	43.8	43.0	48.5	47.3	37.9	49.0
Cherokee, Ariz.	41.6	48.7	43.3	42.5	43.6	44.0	43.6	41.4	48.2	47.1	38.2	48.7
Seligman, Ariz.	41.6	48.7	43.3	42.5	43.5	43.7	43.1	41.1	48.1	47.6	38.3	50.1
Ash Fork, Ariz.	41.7	48.5	43.3	42.4	43.6	43.6	43.1	41.2	48.1	47.7	39.3	50.5
Wiliams, Ariz.	41.7	48.2	43.3	42.1	44.5	43.4	42.9	41.2	48.0	47.0	36.3	49.6
Winslow, Ariz.	41.8	47.8	43.1	42.0	43.1	43.0	42.9	41.0	47.4	45.7	37.3	47.0
Adamana, Ariz.	40.9	46.9	42.4	41.9	42.4	42.6	41.8	40.5	46.4	44.9	36.4	45.6
Gallup, N. M.	40.3	46.3	41.6	41.5	41.9	42.1	41.4	40.1	45.9	44.5	39.0	46.1
Belen, N. M.	39.8	45.8	41.2	40.9	41.4	41.6	41.2	39.7	45.4	43.8	36.3	45.2
Vaughn, N. M.	39.4	44.8	40.5	40.5	40.9	41.0	40.4	39.8	44.4	42.5	35.9	43.3
Glovis, N. M.	39.2	44.5	40.5	40.4	40.9	40.9	40.8	40.3	44.5	45.0	36.9	47.4
Amarillo, Tex.	38.9	44.8	40.3	40.5	41.0	40.8	40.2	41.2	44.7	44.1	35.1	46.4
Canadian, Tex.	38.8	44.8	40.2	40.9	40.8	40.9	40.0	41.3	44.3	44.0	35.8	46.1
Waynoka, Okla.	39.0	45.5	40.5	40.9	40.7	40.9	40.2	41.2	45.3	47.3	35.2	51.2
Wellington, Kan.	38.2	45.7	40.0	41.0	39.9	41.0	40.6	41.0	44.9	45.7	36.6	40.3
Wellington, Kan.	38.8	45.4	40.0	41.5	39.6	40.8	40.7	41.5	44.7	44.5	37.3	47.7
Emporia, Kan.	38.8	45.1	39.8	40.9	39.4	40.7	40.3	40.7	44.3	44.1	37.9	46.9
Argentine, Kan.	38.6	43.9	39.6	40.6	39.2	40.4	40.0	41.1	43.0	42.1	35.9	43.6
Argentine, Kan.	38.5	43.8	39.2	40.2	39.2	40.3	39.3	40.9	42.5	42.9	33.9	44.6
Lexington Jct., Mo.	38.3	43.9	39.2	40.1	39.1	40.1	39.2	40.1	42.7	43.7	33.9	45.2
Shopton, Iowa	37.8	42.8	38.1	39.5	38.1	39.8	38.1	38.2	41.2	40.4	34.6	40.8
Chillicothe, Ill.	37.4	42.3	37.7	39.0	37.9	39.6	38.0	38.0	40.8	41.4	33.6	42.7
Corwith Yards, Chicago	37.1	42.2	37.4	38.7	37.6	39.3	37.5	37.9	40.5	40.1	33.5	40.6
Average	41.9	48.1	42.9	43.0	43.3	44.2	42.6	41.6	47.0	46.9	38.1	49.1

CAR CGW 30000

Bulb No.	Location
1.	Temperature of air at top of floor rack, center of car, 12th stack, center row.
2.	Temperature of air coming out of cold air passage in overhead baffle, center of car, 12th stack.
6.	Fruit temperature top box grapes, 1st stack next end of car, center row.
4.	Fruit temperature of bottom box grapes, 8th stack, center row.
5.	Fruit temperature top box grapes, 4th stack, center row.
6.	Fruit temperature top box praces, 1st stack next end of car, center row.
7.	Fruit temperature, top box grapes, 1st stack next end car, center row.
8.	Fruit temperature bottom box grapes, 4th stack, center row.
9.	Fruit temperature top box grapes, 8th stack, center row.
10.	Air temperature in warm air passage at end of baffle, center row.
11.	Fruit temperature bottom box grapes, 12th stack, center row.
12.	Fruit temperature 5th box grapes above floor, 12th stack, center row.

CAR SFRD 12646

Bulb No.	Location
1.	Temperature of air at floor, center of car, 11th stack, center row.
2.	Temperature of air below ceiling, geometric center of car.
3.	Fruit temperature top box grapes, 11th stack, center row
4.	Fruit temperature bottom box grapes, 7th stack, center row
5.	Fruit temperature top box grapes, 4th stack, center row.
6.	Fruit temperature bottom box grapes, 1st stack, next bulkhead, center row.
7.	Fruit temperature top box grapes, 1st stack next bulkhead, center row.
8.	Fruit temperature bottom box grapes, 4th stack, center row.
9.	Fruit temperature top box grapes, 7th stack, center row.
10.	Air temperature at top of bulkhead opening, warm air returning to ice tank.
11.	Fruit temperature bottom box grapes, 11th stack, center row.
12.	Fruit temperature 5th box grapes above floor, 11th stack, center row.

APPARATUS.

The temperature observations taken in the cars throughout the test were obtained by means of Leeds & Northrup resistance type electrical thermometers obtained from the U. S. Department of Agriculture, Bureau of Markets, and were calibrated, previous to installing in the test cars, by means of an ice bath. The locations of the bulbs for recording the temperature of the lading are given in the footnotes to Table I. A balanced indicator was used for reading the car temperature from the outside, so that it was not necessary to open the doors en route to obtain the temperatures of the fruit.

The amount of ice used in each car during the test was

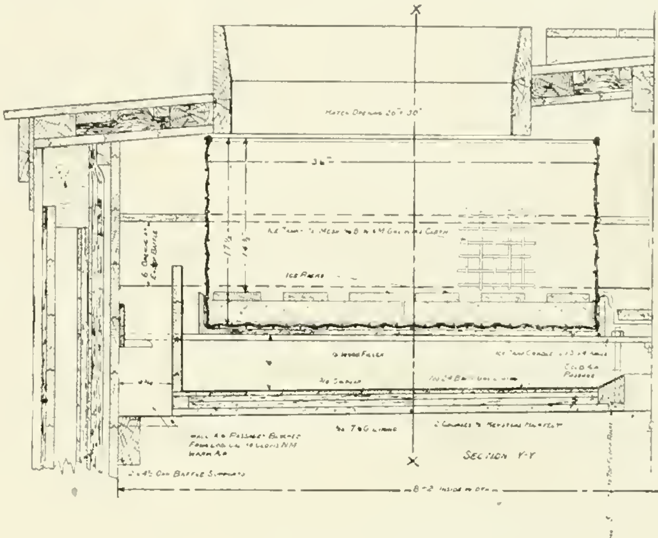


Fig. 2. Cross Section Through Overhead Tank. C. G. W.-30,000

estimated from full cakes of artificial ice in order to more accurately determine the amount. Outside temperatures throughout the test were obtained by means of mercury thermometers, read as often as practicable. The resistance bulbs were located in the head end of each car only. No temperature readings were taken in the rear half of the test cars.

METHOD OF TESTING.

After the cars were selected at Calwa, Cal., they were forwarded dry to Stockton, Cal. At Stockton CGW 30000 had

the six warm air passages at the side walls blocked, as shown in Fig. 1. These passages were blocked to see if greater uniformity of temperatures could be obtained than if left open. The passages remained blocked from the time the cars were loaded at Lodi, Cal., up to Clovis, N. M., where they were all opened, thus permitting the air to circulate up the side wall passages into the ice tanks as well as through the air passage at the end of the baffle.

The cars were pre-iced at Stockton at 6 p. m. October 7 at the Santa Fe ice plant, where 10,500 lb. of ice were placed in the bunkers of SFRD 12646 and 4,275 lb. of ice in the tanks of CGW 30000. The small amount of ice furnished CGW 30000 as compared to the total ice tank capacity (6,300 lb.) was due to the poor manner in which this car was iced at that point. No salt was used in either car at any time during the test. After initial icing both cars were forwarded to the warehouse of the T. H. Peppers Company at Lodi, Cal., via the Central California Traction Company, where they were loaded on October 8.

The loading of the cars commenced at 8 a. m. and was completed at 2:30 p. m. The ends of both test cars in which the electrical thermometers were located were loaded first.

Temperature readings by means of mercury thermometers during the loading period showed that the grapes were at a temperature of 59 deg. F. in both cars.

SFRD 12646 was loaded with 1,050 standard crates of grapes, weight 29,400 lb., 10 layers high, 5 rows wide and 11 stacks long in the end in which the electrical thermometers were located, and 10 stacks long in the opposite end. CGW 30000 was loaded with 1,072 standard crates of grapes, weight 30,016 lb., 9 layers high, 5 rows wide and 12 stacks long in the end in which the thermometers were located, and 11 and 12 stacks long in the opposite end. In both test cars the regulation center bracing for grape cars was used to prevent the load shifting in transit.

Both cars were sealed at 2:30 p. m., at which time initial temperature readings of the electrical thermometers were taken. Both test cars were billed to Chicago, Ill., under standard refrigeration; routed Lodi to Stockton, Central California Traction Company, Stockton to destination, Atchison, Topeka & Santa Fe.

The temperatures of both cars, as well as the total amount of ice furnished and the outside temperatures, are shown in Table I. The following table gives the amounts of ice furnished at each icing station en route, as well as the total amounts furnished:

		CGW 30000		SFRD 12646	
Location	Date	Amount, Lb.	Total Amount, Lb.	Amount, Lb.	Total Amount, Lb.
Stockton, Cal.....	Oct. 7, 1919	4,275	4,275	10,500	10,500
Stockton, Cal.....	Oct. 8, 1919	1,710	5,985	1,995	13,495
Bakersfield, Cal. ..	Oct. 9, 1919	2,550	8,535	1,950	14,445
Needles, Cal.	Oct. 10, 1919	1,300	9,835	1,750	16,195
Winslow, Ariz. ...	Oct. 12, 1919	1,100	10,935	1,100	17,295
Belen, N. M......	Oct. 13, 1919	400	11,335	700	17,995
Clovis, N. M......	Oct. 13, 1919	800	12,135	550	18,545
Waynoka, Okla. ..	Oct. 14, 1919	1,250	13,385	1,000	19,545
Argentine, Kans. ..	Oct. 16, 1919	2,000	15,385	1,700	21,245
Corwith Yards, Chicago, Ill.	Oct. 18, 1919	500	15,885	1,100	22,345

The cars left Lodi, Cal., at 3:15 p. m. October 8 and arrived at Corwith Yds., Chicago, at 1:15 a. m. October 18, thus making the total time for the 2,470-mile trip 9 days, 9 hrs. and 55 min., or an average speed of 11.0 miles per hour.

After the cars arrived at Corwith Yards on the morning of October 18 no further temperature observations were taken. Cars were moved to the Twenty-first street yards of the Santa Fe, where the electrical thermometer equipment was removed. The cars were held at the yards for consignee's order and for inspection of the fruit by the consignee's inspectors, Santa Fe inspectors and inspectors of the Inspection Service, U. S. Department of Agriculture, Bureau of Markets.

GENERAL RESULTS.

As shown by the table above, the total amount of ice furnished SFRD 12646 was 22,345 lb. and for CGW 30000 was 15,885 lb., a difference of 6,420 lb., or 28.8 per cent in favor of CGW 30000. Both cars had the ice tanks filled to the same capacity at the final reicing at Corwith, as at the initial icing at Stockton. The total amount of ice melted in each is the difference between the total amount of ice furnished in transit and the initial icing. This gives 11,845 lb. melted in SFRD 12646 and 11,610 lb. melted in CGW 30000, or an ice rate of 47.2 lb. per hr. for SFRD 12646 and 46.3 lb. per hr. for GGW 30000.

In the end ice tank car it was necessary to keep the bunkers full of ice in order to secure proper refrigeration, as the ice in the lower portion of the bunkers afforded very little, if any, effective refrigeration; the car equipped with overhead ice tanks had all of the ice located so as to create refrigeration, thus making it possible to carry less ice and yet obtain the same temperature.

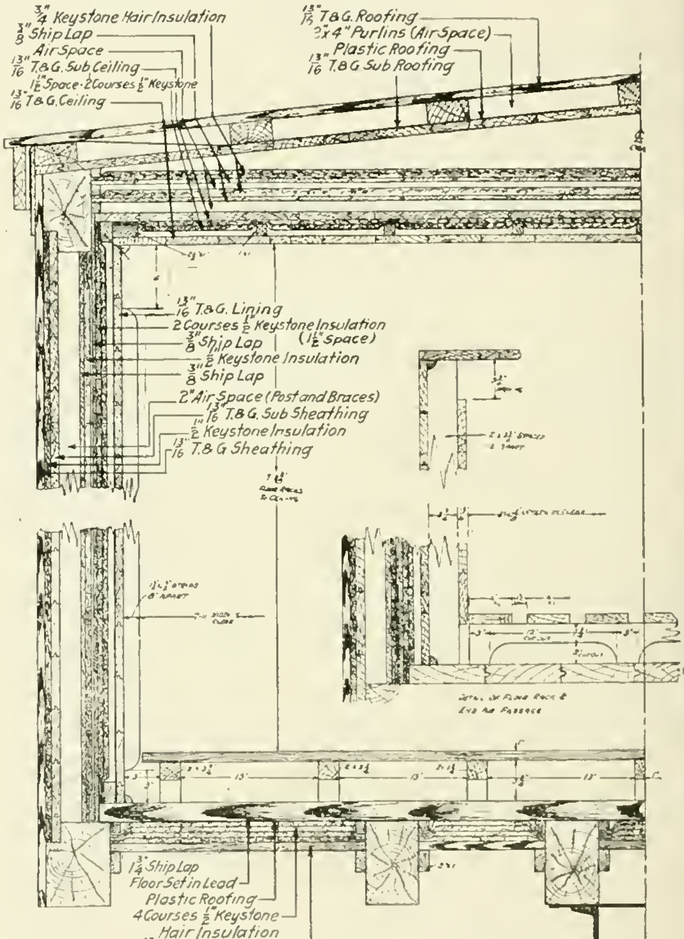


Fig. 3. Cross Section of Car C. G. W.-30,000

The chart in Fig. 5 is plotted from the average of fruit temperatures taken at the bottom and top layers of fruit. Bulbs number 3, 5, 7 and 9 were averaged to show the fruit temperatures of the top layer; bulbs number 4, 6, 8 and 11 were used for averaging fruit temperatures in the bottom layer. This chart and the data in Table I, giving the temperature comparisons in both cars, show that at times there was no difference in the temperature of the fruit in the bottom and top layers of car CGW 30000; that the maximum difference was 1.4 deg. F., and the average difference was 0.4 deg. F.

The minimum difference in the temperatures of the fruit in the bottom and top layers of SFRD 12646 was 5.6 deg.

F. The maximum difference was 14.3 deg. F., and the average difference was 8.6 deg. F. The maximum difference occurred at the commencement of the test while the temperature of the fruit was being reduced.

The marked uniformity in the temperature of the fruit in car CGW 30000 demonstrated a uniform circulation of refrigerated air throughout the entire load. The temperature of bulb No. 2 in SFRD 12646, located six inches below the ceiling at the geometric center of the car, fluctuated considerably and was affected more by the outside air temperatures than any other thermometer, as shown in Table I. This fluctuation was due to the heat passing through the roof of the car, affecting the air furthest from the ice tanks. Due to the location of the ice in the car equipped with the overhead refrigeration system, any heat passing through the roof of the car must have been prevented from reaching the load by its immediate absorption by the ice in the overhead tanks.

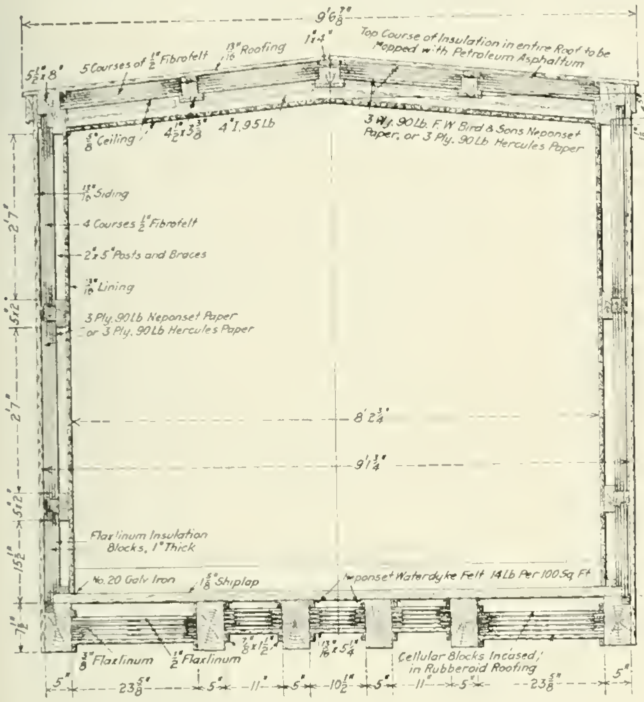


Fig. 4. Cross Section of Car A. T. & S. F.-12,646

At the time the fruit was loaded its temperature was 59 deg. F. At the time the car was sealed the average temperature of the fruit in the top layer of CGW 30000 was 58.0 deg. F. and in the bottom layer 56.6 deg. F. The temperature in the top layer of SFRD 12646 was 59.8 deg. F. and in the bottom layer 52.0 deg. F. This shows that the fruit in the bottom layer of the latter car had cooled 7.0 deg. F.; while the fruit in the top layer had increased 0.8 deg., that the fruit in the top and bottom layers of CGW 30000 was cooled 1.0 deg. and 2.4 deg., respectively. At destination the average fruit temperature of the top layer in CGW 30000 was 38.9 deg. F. and the bottom layer 38.5 deg. F., a difference of 0.4 deg. In SFRD 12646 the average temperature at destination in the top layer was 41.6 deg. F. and in the bottom layer 36.0 deg. F., a difference of 5.6 deg.

The top layer of fruit throughout the test averaged 47.7 deg. F. for SFRD 12646 and 44.7 deg. F. for CGW 30000, or 3.0 deg. lower in car CGW 30000 than SFRD 12646. The temperature at the lower layer in SFRD 12646 is affected by the cold air coming directly off the ice, which accounts for the lower temperatures of this layer.

The bottom layer of fruit throughout the test averaged 44.3 deg. F. for CGW 30000 and 39.1 deg. F. in SFRD 12646, or 5.2 deg. lower in SFRD 12646 than CGW 30000. No effect was noticed in the temperatures throughout the load in CGW 30000 when the side wall air passages were either blocked or left open.

ICING IN TRANSIT.

In constructing CGW 30000 with the improved overhead icing system several changes were made in order to secure maximum refrigeration and uniform circulation throughout the car. The car had previously been equipped with six hatches; these were not altered to instal the six overhead ice tanks. The hatches were not originally designed to be used

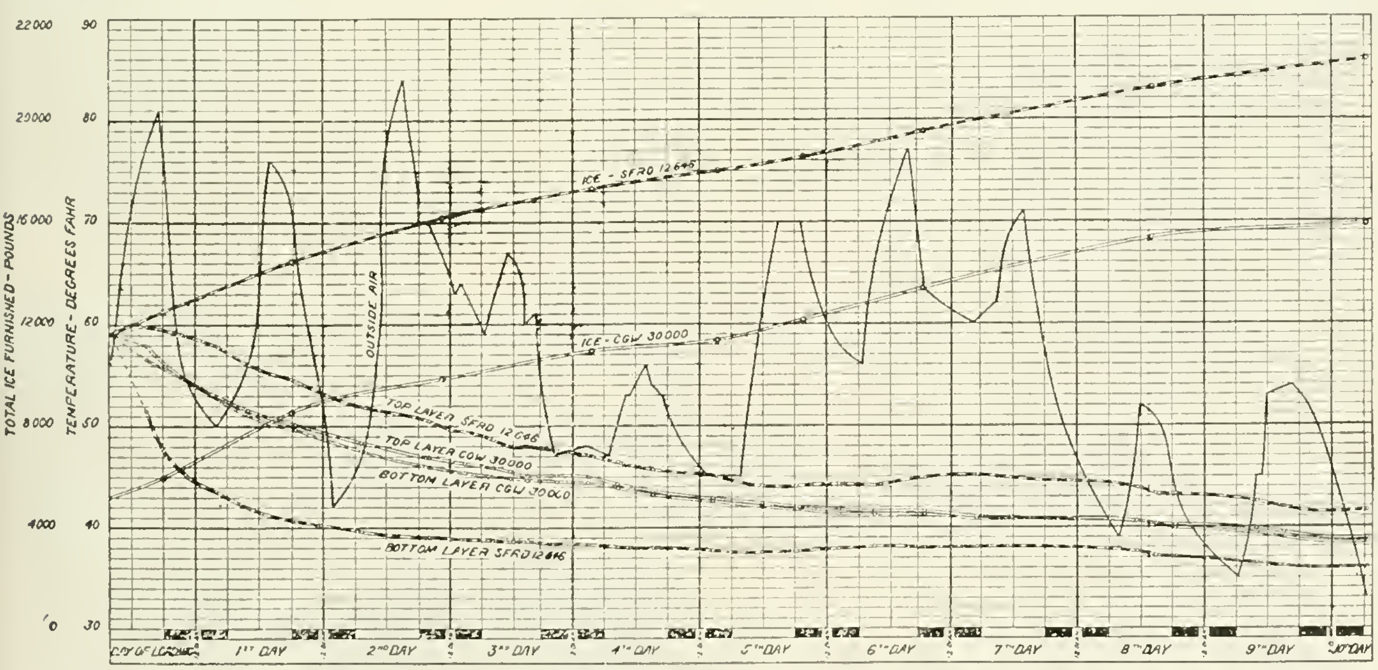


Fig. 5. Range of Temperature and Ice Furnished During Refrigeration Test

with the ice tanks, as finally installed in the car, and difficulty was encountered during the test in icing this car; considerable more time was required to properly ice this car than the other test car equipped with end ice tanks.

The objectional feature in icing this car can be overcome

by using tanks setting transversely and lengthening the hatchways, so that each tank can be iced from two hatchways. The construction and insulation of CGW 30000 with the overhead ice, tanks are shown in Figues 1, 2 and 3.

INSPECTION AT CHICAGO.

Three separate inspections of the grapes in the two test cars were made at the yards of the Santa Fe by consignee's inspectors, by Santa Fe inspectors and by government inspectors of the Inspection Service, Bureau of Markets, U. S. Department of Agriculture.

The consignee's inspection report showed that the grapes in SFRD 12646 were decayed and moulded much more than those in GGW 30000, the difference in the quality of the grapes in the two cars being great enough to cause the consignee to unload those in SFRD 12646 at Chicago and to divert CGW 30000 on to New York market.

The Santa Fe's inspection report showed "slight decay and mould in CGW 30000, some decay and mould in SFRD 12646, four crates in top layer near doorway slightly wet, caused apparently by leak from roof." These statements infer that the grapes in CGW 30000 were in better condition than those in SFRD 12646 and corresponds to the condition found by consignee's inspectors.

The reports from the Inspection Service of the Bureau of Markets, U. S. Department of Agriculture, are as follows:

SFRD 12646—Stock well packed, highly colored, and presents attractive appearance: a few mouldy berries scattered through top half of load, as noted above (top 5 layers crates, balance of load practically no decay). Impossible to inspect entire car without unloading: certificate restricted to one stack crates next bracing, each end of car. Temperature top of door 46 degrees F., bottom 42 degrees F.

CGW 30000—Decay in this car slightly in excess of that in car SFRD 12646. Stock well packed, highly colored, a few scattered mouldy berries, showing very good appearance. impossible to inspect entire car without unloading: certificate restricted to one stack crates next bracing, each end of car. A few mouldy berries scattered throughout most crates, also many berries showing slight mould at stems. Temperature at top of door 42 degrees F., bottom 40 degrees F.

It does not seem that the consignee would have diverted CGW 30000 to New York and unoladed SFRD 12646 if the inspection as shown by government inspectors had been true. The temperatures shown by the government inspection report at the door was 4 deg. lower at the top in CGW 30000 than in SFRD 12646 and 2 deg. lower at the floor of the car, notwithstanding their claim of there being less decay in SFRD 12646.

The four crates, "slightly wet," referred to in the Santa Fe inspection report, resulted from condensed moisture dripping from four baffle supporting bolts which were not properly protected.

CONCLUSIONS.

1. Car CGW 30000, equipped with overhead ice tanks, was furnished with 28.8 per cent less ice than car SFRD 12646, equipped with end ice tanks.

2. At times there was no difference in the temperature of the fruit in the top and bottom layers of car CGW 30000: the maximum temperature difference was 1.4 deg.: the average temperature difference was 0.4 deg.

3. The minimum temperature difference of the fruit in the top and bottom layers of car SFRD 12646 was 5.6 deg.; the maximum temperature difference was 14.3 deg.: the average temperature difference was 8.6 deg.

4. The fruit in the top layer of CGW 30000 throughout the test averaged 44.7 deg. F. and that in SFRD 12646 averaged 47.7 deg. F., or 3.0 deg. higher than in the same layer of CGW 30000.

5. The fruit in the bottom layer of CGW 3000 throughout the test averaged 44.3 deg. F. and that in SFRD 12646 averaged 39.1 deg. F., or 5.2 deg. lower than in the same layer of CGW 30000.

6. The temperatures in test car CGW 30000 showed that the air circulation was practically uniform throughout the entire load, giving substantially uniform temperatures in all the creates of grapes.

7. The temperature in test car SFRD 12646 showed that the air circulation was not uniform throughout the load, causing an extremely wide variation of temperatures in the grapes in the bottom and top layers.

8. The time required for icing CGW 30000 was considerably greater than SFRD 12646, but by changing the design of the ice tanks and hatches practically the same time would be required for icing both cars.

9. The condition of the grapes in CGW 30000 was much better than in SFRD 12646, the percentage of decayed grapes running much higher in SFRD 12646 than in CGW 30000.

10. Consignee's inspection reports on the condition of the grapes in the two test cars upon arrival in Chicago warranted them forwarding CGW 30000 on to New York market and in their unloading those in SFRD 12646 on the Chicago market.

11. The inspection report on the condition of the grapes in the test cars upon arrival in Chicago, made by the Inspection Service of the Bureau of Markets, U. S. Department of Agriculture, was superficial, since only one stack of crates in each end of car was inspected, and was contradictory to the other reports, both of which showed less decay in CGW 30000 than in SFRD 12646.

12. On the whole, the test showed the performance of CGW 30000 to be superior to SFRD 12646, since it used less ice, gave a substantially uniform temperature throughout the entire car and carried the load in better condition than the other car.

This test was made by G. J. Congdon, supervisor fuel and refrigeration, Chicago Great Western, and witnessed by Lester W. Collins, mechanical engineer, Refrigerator Heater & Ventilator Car Company, St. Paul, Minn. The test was made possible through the co-operation of the shippers, T. H. Peppers Co.; consignee, Crutchfield, Woolfolk & Clore; the officials and employees of the Santa Fe Refrigerator Despatch Co., and Santa Fe Railroad. The Bureau of Markets, U. S. Department of Agriculture, Washington, D. C., loaned sufficient electrical thermometer equipment for conducting the test.

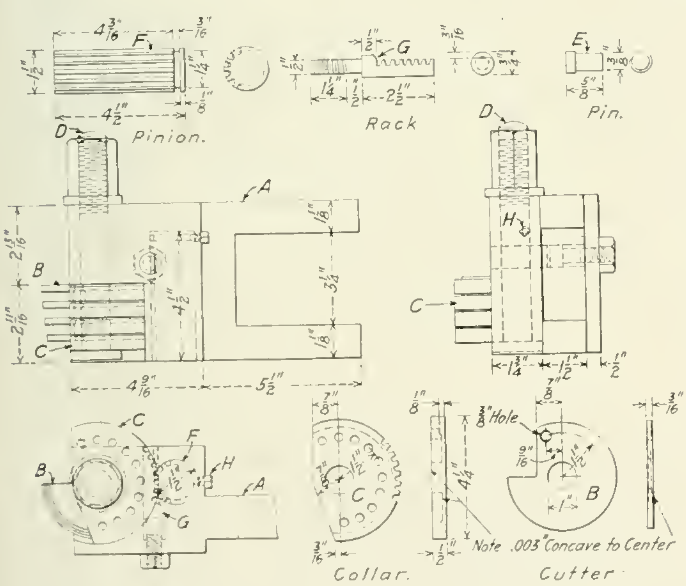
Scene on the South African Government Railways

Shop Practice

GANG CUTTERS FOR PISTON RINGS

In the operation of a railroad repair shop there are many ways in which economies can be effected, and in no other way can more be done in this respect than in the many small jobs on machines.

A rapid and economical means of cutting piston rings on a boring mill has been devised in the Canadian Pacific shops and is illustrated in the accompanying drawings. The device consists of a holder *A*, in which are inserted four cutters *B*, each having an individual collar *C*, all secured in the holder by the bolt or pin *D*. The cutter *B* is provided with a 3/8-in. hole so located as to coincide with any one of a series of similar holes through the collar *C*, by means of which the cutter can be secured in any position that may be desired, by inserting the pin *E* in the holes. The collars are provided with teeth which mesh with similar teeth on the pinion *F*. Adjustment of the cutters may be obtained



Details and Assembly of Piston Ring Gang Cutters

by a movement of the rack *G*, which also has teeth meshing with the pinion *F*. After the cutters are adjusted to the position the set screw *H* is tightened, thus securing the cutters in the desired position.

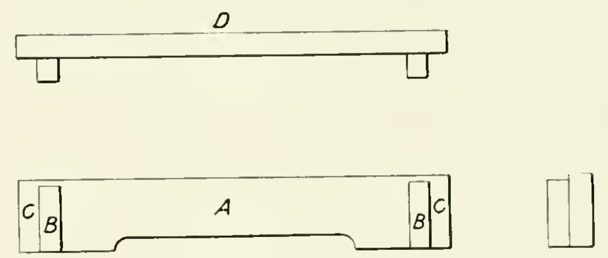
As will be seen from the drawings, the cutting edges of the cutters *B* may easily be ground without any decrease in the diameter of the cutter and, consequently with no change in the thickness and spacing of the cutting edges. The particular cutters illustrated were designed for piston rings 3/8 in. thick, but the idea may be adapted to any size desired, or if conditions make it necessary, the number of rings cut at one operation may be increased or decreased as may be advisable.

The use of this device has permitted a considerable economy in the Canadian Pacific shops. Its advantages are obvious, as the high cost of labor at the present time makes it necessary to utilize machines and men to their full capacity.

MACHINING VALVE PACKING STRIPS

BY A. W. C.

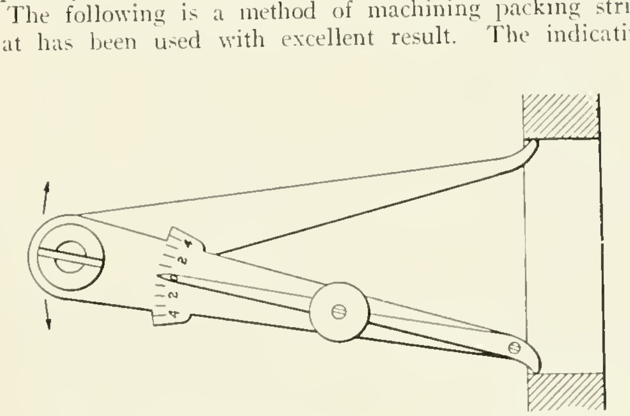
The proper machining and fitting of the packing strips used in balanced slide valves is of great importance, as any leakage of steam by these strips is a total waste. New men when given the short strips to shape are often puzzled as to the best way to machine them, as they are difficult to get at to caliper. Usually the surface *A* between the lugs is finished first on a shaper, surfaces *B* and *C* being shaped at the same time and care being taken that surfaces *C* are finished with



Typical Diagram of Valve Strip

the tool set at the same depth as when finishing surface *A*. The strip is then laid with surface *A* or surfaces *B* on a parallel and machined on surface *D*. The strips are calipered at either or both ends with more or less satisfactory results. The necessity of having surfaces *C* finished exactly in line with surface *A* is here seen, otherwise incorrect calipering results. When cutting surface *D* it is necessary to take a cut over far enough to get the calipers on, and it is this cutting and calipering that is the time consuming operation, especially when a large number of strips are machined.

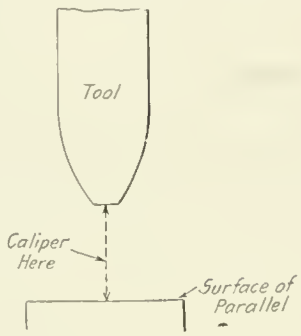
The following is a method of machining packing strips that has been used with excellent result. The indicating



Type of Caliper Used for Gaging Thickness

caliper or gage illustrated is first lightly clamped to a tool shank by a small clamp and used as an indicator would be to determine if the parallel is really parallel with the shaper ram's travel. Any discrepancies are remedied by tissue paper liners. The parallel used is of a length that will allow the strip to be placed with surface *A* on it (about seven inches long), this surface having been finished first. No particular

care is given surfaces *B* or *C*, which eliminates one time-consuming feature. The valve groove is then measured with the calipers by tapping the solid leg until the indicator registers on any graduation, the graduation being noted. A broad-nosed tool is held in the tool post, the tool having a small flat ground on it, as illustrated. The caliper is placed between the parallel and tool and the tool is adjusted vertically until the indicator shows that the tool is a distance from the parallel equal to the width of the groove in the valve; that is, the indicator points to the same graduation as it did when in the groove. The vertical micrometer collar is now set at zero and a roughing cut taken over the strip which is held on the parallel by a pair of shaper hold-downs. A finishing cut is next taken after feeding the tool down a few thousandths. Once having decided how many thousandths to run the tool down, it is an easy matter to fit all strips uniformly, as each strip can be made any desired number of thousandths smaller than the grooves. The filing and spotting of the strips is thus reduced to a minimum, which saves 25 to 50 per cent on the machining time.



Method of Setting Tool

PRESSURES FOR MOUNTING WHEELS AND APPLYING CRANK PINS

BY JAMES PARTINGTON
Estimating Engineer, American Locomotive Company

In locomotive and car construction, it is the general practice to use hydraulic pressure for mounting wheel centers on axles, applying crank pins, etc. The different operations involved may be classified as follows:

1. Mounting cast iron driving wheel centers.
2. Mounting cast steel driving wheel centers.
3. Applying crank pins in cast iron driving wheel centers.
4. Applying crank pins in cast steel driving wheel centers.
5. Mounting cast iron truck wheel centers.
6. Mounting cast steel or wrought steel truck wheel centers.
7. Mounting cast iron chilled tread truck wheels.
8. Mounting cast steel or rolled steel truck wheels.

Very little information seems to be available in printed form to indicate the pressures which should be used for these different operations and the following table showing the practice of the American Locomotive Company has been found by long experience to give satisfactory results. The basis of this table as worked out for operations, (1) and (3), was the commonly accepted formula for cast iron centers which calls for 10 tons pressure per inch of diameter of the shaft. These pressures have been consistently adhered to for cast iron driving wheel centers, having been amplified only to the extent of permitting a minimum pressure of 10 per cent less and fixing 20 per cent excess pressure as the allowable maximum.

For operations (5) and (7), the pressures required have been reduced somewhat because the requirements for truck wheels are not as exacting as for driving wheels and the greater pressures approach too closely to the point at which the smaller diameter axles may bend. The reason for this reduction is readily apparent when it is considered that the relative stiffness of axles is expressed in terms of the cube of the diameter and the table of pressures is made in terms of the first power of the diameter.

In the table covering truck wheel mounting pressures, it will be noted that the figures followed by an asterisk are the Master Mechanics and Master Car Builders' Standards of 1916 as are also the preferred pressures used for cast iron and cast steel wheelcenters. For operations (2) and (4) covering cast steel driving wheel centers, having wheel fits, or crank pin fits 6½ in. in diameter or over, the preferred mounting pressures have been increased to 16 tons per inch of diameter with a minimum of 10 per cent less and a maximum allowable excess of 25 per cent above the preferred pressure. These increased pressures have been adopted for steel centers on account of the different characteristics of the material; *i. e.*, a somewhat lower coefficient of friction and a greater uniformity in the strength of the metal to resist fracture.

For operations (2) and (4) with wheel fits and crank pin fits under 6½ in. in diameter, the preferred mounting pressures are 13 tons per inch of diameter, and for the very small sizes, which are never used in ordinary locomotive practice, 11 tons per inch of diameter. For operations (6) and (8) the mounting pressures have been reduced for the same reasons as outlined for operations (5) and (7).

It will be noted that the mounting pressures for cast steel or wrought steel truck wheel centers, and cast steel or rolled steel trucks wheels, also agree with the Master Mechanics and Master Car Builders Standards of 1916. Locomotive trailing truck wheels over 36 in. in diameter are placed in the same classification as driving wheels in determining the mounting pressure. Crank pins and wheels applied at the pressures given in this table have given uniformly satisfactory service for a long period of years.

Table of Mounting Pressures Used by the American Locomotive Company

MOUNTING PRESSURES IN TONS

	Axles and crank pins in: Driving wheels, trailing wheels (over 36 in. in diam.)						Axles in: Engine truck wheels, trailing truck wheels (36 in. in diam. and under), tender truck wheels				
	Cast steel centers			Cast iron centers			3.78¾	Cast steel or wrought steel centers. dollars for		Cast iron centers. £.. 22.3	
							Wheel seat diam.	Cast steel or solid w. steel		Cast iron chilled tread	
Seat diam. in in.	Min.	Prefd.	Max.	Min.	Prefd.	Max.	in in.	Min.	Max.	Min.	Max.
2½	25	28	35	22	25	30	4	35	50	25	35
3	30	33	41	27	30	36	4½	40	55	30	40
3½	35	39	49	31	35	42	5	45	60	30	45
4	**47**	**52**	**65**	36	40	48	5⅛*	45*	60*	30*	45*
4½	53	59	74	40	45	54	5½	50	70	35	50
5	58	65	81	45	50	60	5¾*	50*	70	35	50*
5½	65	72	90	49	55	66	6	55	75	35	55
6	70	78	98	54	60	72	6½*	60*	80*	40*	60*
6½	94	104	130	58	65	78	7*	65*	85*	45*	65*
7	101	112	140	63	70	84	7½	70	95	50	70
7½	108	120	150	67	75	90	7⅝*	70*	95*	50*	70*
8	115	128	160	72	80	96	8	70	95	50	70
8½	122	136	170	76	85	102	8½	75	100	55	75
9	130	144	180	81	90	108	9	80	105	...	...
9½	137	152	190	85	95	114	9½	85	115	...	...
10	144	160	200	90	100	120	...	...	...	...	...
10½	151	168	210	94	105	126	...	...	...	...	...
11	158	176	220	99	110	132	...	...	...	...	...
11½	166	184	230	...	...	...	...	...	...	...	...
12	173	192	240	...	...	...	...	...	...	...	...
12½	180	200	250	...	...	...	...	...	...	...	...
13	187	208	260	...	...	...	...	...	...	...	...
13½	194	216	270	...	...	...	...	...	...	...	...

*M. M. and M. C. B. standards of 1916.

European Equipment.—According to the British Ministry of Transport, 6 per cent of the cars are out of service awaiting repairs. The percentages of some other countries are: France, 15; Italy, 18; and Austria, 35. The percentage of locomotives awaiting repairs is 21 in Great Britain; in France, 22; Italy, 27; and Austria, 37.—*The Engineer.*

Railway Shop Conditions In England

High Cost of Labor and Decreased Output Is Building up Excessive Costs—Great Need for Improved Devices and Modern Machinery

By ROBERT E. THAYER

European Editor of the Railway Mechanical Engineer

As a direct heritage of the war England has had, in common with almost every other nation, to face a very great increase in the cost of labor. Wages have not only increased but output has been decreased through the adoption of the eight-hour day and a general decline in the morale of the workmen. The English railways and particularly the railway shops have felt these changed conditions keenly, more keenly perhaps than any other industry and surely more keenly than the railway shops of America on account of the fact that before the war English railways never had much worry over the cost nor the quantity or quality of labor.

With plenty of cheap and well trained workmen before the war, there was not the incentive for English railroad shop managements to adopt more modern systems of shop operation or improved shop appliances and labor saving machinery that existed in America where wages were high and skilled workmen were scarce. Furthermore, with cheap, well skilled labor and more or less unrestricted finances there has been every incentive for the railway mechanical officers in Great Britain to produce equipment that from the view point of workmanship was a work of art. Under the present conditions, however, this perfection in construction involves a high manufacturing cost that is being felt. In addition to this there has not been the demand for improved and new shop equipment to handle new equipment of increased weight and dimensions as in America, on account of the fact that the physical characteristics of the English roads, such as structural clearances and permissable weight on rail, have not permitted these roads to extend to the same extent as in the States. The equipment of 30 or 40 years ago is now not out of place on English roads. As a matter of fact there is still in operation much of the equipment built at that time. The English railway mechanical officer has therefore devoted the greater part of his time and energy on refinements in construction and design rather than on the increased size of his equipment or improved shop equipment.

The situation as it exists today presents an entirely different story. Labor is no longer cheap; output has been curtailed; materials have increased in price, and heavy deficits in net revenue present a demand for economy. The cost of maintenance and renewals of English rolling stock (including locomotives) has increased from £13,257,617 in 1913, to £14,156,816 for the first six months of 1919, or an increase of 213 per cent. The cost of locomotive running expenses has increased from £17,130,661 in 1913, to £18,168,-295 for the first six months of 1919, or an increase of 212 per cent. If the railways of Great Britain are to meet expenses they either must increase their rates or operate more economically. There are great opportunities for savings to be made in the mechanical departments but investment will be necessary in shop equipment, and new and improved methods both in design, construction and repairing equipment will be necessary.

Locomotive building practices in Great Britain involve the use of more expensive materials and a higher grade of workmanship than is demanded in the United States. The English locomotives have copper fireboxes, copper dry pipe and copper stay bolts, (about 2½ tons). In numerous instances these engines will be provided with copper tubes although with the present high cost of copper, steel tubes are more generally used. In addition to this many roads have a standard practice of using bronze driving boxes (about 550 lb. each) instead of cast steel driving boxes with the crown brass as is common in the States. This greatly increases the overhead cost of the locomotive and adds a greater carrying charge which naturally affects the net returns, particularly with copper at £105 and bronze at £180 per ton. There are but few locomotives that are provided with wedges in the pedestals, the designer preferring to provide an accurate sliding fit between the driving box and the pedestals in preference to bothering with shoes and wedges. This requires expensive fitting. The motion work in a number of cases is fitted on a testing table before it is placed on the locomotive. One road follows the practice of fitting its cylinders, crosshead guides, guide yoke, etc., on a dummy engine frame in order to ensure proper alinement, before they are placed on the locomotive.

> Butt riveted boilers, concave journals and bronze driving boxes are some of the unusual features of construction found on British locomotives.

The boiler practice is also carried to a higher degree of refinement than is used in the States. Many roads have what is called a parallel boiler, that is the different courses are butt riveted with a welt strip shrunk on. The barrel sheets are not laid out for the rivet holes on the flat but are assembled and each rivet hole is drilled in a huge machine called a boiler barrel drilling machine. Most English roads use inside cylinders with cranked axles of both the solid and built-up type. Furthermore it is not uncommon to find the rear driving axles with concave journals and driving boxes fitted to these journals although it should be said that no new engines are built in this manner. It is a standard practice in flue works on some roads to stretch the flues after they have been removed from the boiler under repair to make up for the length cut off in removing the flues. In some cases tubes are stretched nine inches. This applies to both copper and steel tubes. In other shops safe ends are brazed on to the tubes, the safe end being milled and the tube taper-turned for fitting and a joint made with a copper ferrule. All spring work is done by hand, the methods of the past being perpetuated.

The railway shops themselves in many cases are old, representing a gradual development only in size. Railway shop practice, due as mentioned above to the fact that the cost of labor was so cheap before the war, has not progressed. Where American roads are now endeavoring to get away from as much fitting and bench work as possible, not only due to its excessive cost but on account of the fact that it is difficult to obtain first class machinists for this work, one finds in the English railway shop a large area of the shop space given over to this bench work.

It is all of these things which contribute to the excessive

cost of locomotive construction and repairs and it is here than the greatest field for economy is presented. The Railway Gazette, one of our London contemporaries, recently commented on the bids offered by British and American locomotive manufacturers on an order for the Egyptian State Railways. These figures show that the British builders quoted a price from 76 to 81 per cent higher than the successful American bidder. This will illustrate how the new conditions in the labor and material markets have affected British practices and give an indication of the necessity for more up-to-date shops in Great Britain.

The English roads generally build their own power and the British locomotive manufacturers deal more particularly with export business. As a result of this the English railroad will have under the jurisdiction of its mechanical department a more or less complete locomotive manufacturing plant. Taking one case in particular, that of the Crewe shops of the London & North Western, it might be stated that that plant needs only a coal mine and an iron mine located on its premises to make it self-supporting. The spreading out of locomotive building plants in this manner has also tended to increase the cost of locomotive manufacture, particularly on account of the fact that most of these plants are badly equipped.

As regards car building a similar policy is followed, that is, very few roads go outside for their new freight or passenger cars. A fine passenger car is built by the English railroads which in common with locomotives involves much labor. In contrast to this, however, are the freight cars which are nothing more or less than ordinary wagons mounted on axles and provided with an ordinary lever hand brake. The general size of these wagons is either of 10 or 12-ton capacity. They are simplicity itself in construction and due to the large number required to handle the business make a profitable manufacturing proposition for the individual railroads. But a very small number of these wagons are equipped with automatic brakes. They are principally of wooden construction, although due to the high price of timber a number of steel underframe cars are being built. The wheels are of a built-up design made in the car manufacturing plants. The shop cost for a pair of 38-in. wheels mounted on an axle having 9-in. by 4-in. journals is approximately $125. The English roads have considered the use of cast-iron wheels but not having been sufficiently impressed with their safety, they still adhere to their own design of built-up wheel. The cost of these freight cars has increased greatly. Before the war a 12-ton open top car could be built by the railways for about $400, but the present cost has been recently quoted as about $1,000 in railway shops and about $1,500 in car building plants. The car shops are more or less in the same category as the locomotive shops. There are some well laid out and well equipped shops on certain roads. Perhaps that of the Midland at Derby is the best in England. This shop contains many modern and improved woodworking tools, most of which were obtained from America.

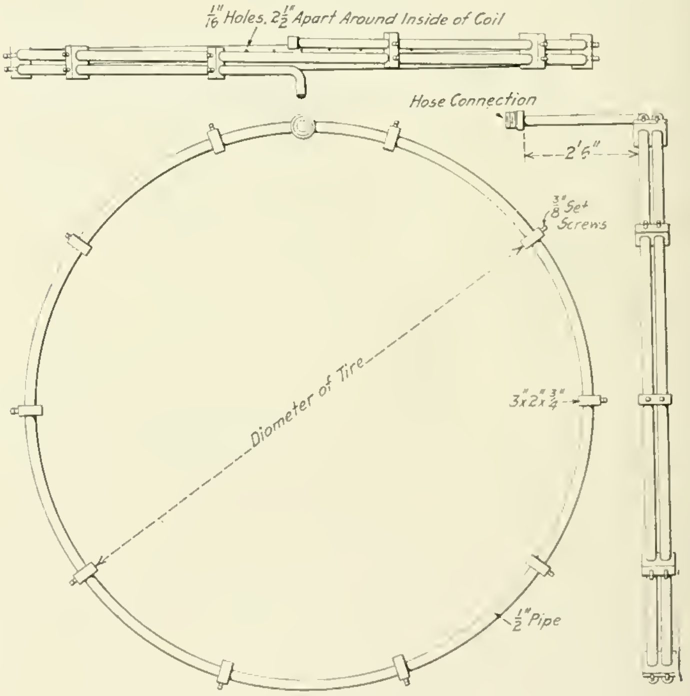
This brief review of railway shop conditions in England indicates a wonderful possibility for improved railway shop appliances and machinery. Something must be done to reduce the excessive cost of manufacture and repairs, and with labor and material conditions so vitally different from what they were before the war, the railway shop managements are seeking a way out of the difficulty. It may be argued that with the English railroads in the hands of the government and with a standard net return guaranteed the shareholders, the English railroads will not be as anxious to make immediate improvements to their plants which would involve heavy expenditures. Government control will not run much more than 18 months hence and at the end of that time if the roads go back to their private owners economies must be anticipated to the greatest possible extent. On the other hand, if the government retains control of the roads either through nationalization or otherwise there will still be the necessity for improvements. It is not believed, however, that the railways will defer taking action in such matters until they pass out of the hands of the government and in fact serious thought is being given to the modernization of railway shops by many of the more important of the British railroads.

LOCOMOTIVE TIRE HEATER

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

When the railway shops were required to use crude oil or kerosene in place of gasoline in tire heaters considerable difficulty was experienced. Many experiments were made and a number of different designs worked out more or less satisfactorily, but at times there was trouble in getting the heaters to start promptly. Time and oil were wasted and sometimes the shop was filled with gas and smoke from the oil, which, together with the flames, was not only annoying but dangerous.

To overcome these difficulties the tire heater illustrated was designed by N. Carlson, pit foreman of the Duluth & Iron Range at Two Harbors, Minn. The heater consists of a piece of ½-in. iron pipe, bent in a continuous double helical coil, with spacing blocks to keep the pipes in the right position and the right distance from the tire. It is important that the latter distance so adjusted that the hottest point of the flame is at the tire. The first section of the coil has no small holes in it and merely acts as the preheater. The second section, which goes next to the tire flange, is provided with a continuous row of 1/16-in. holes, drilled 2½ in. apart. The usual form of oil container and vaporizer is then connected to the shop air line and to the tire heater by a hose connection.



Tire Heater Which Vaporizes the Oil Before Burning

This form of tire heater has proved to be both easy to start and economical in the use of oil. It is possible to obtain a good blue flame with kerosene, and by making coils of suitable diameters any size of tire can be heated in a satisfactory manner.

How Jim Dugan Finally Won A "Real" Job

Everything Went Wrong at Crossover Until He Took a Fresh Hold. First Entry in the Prize Story Contest

BY ANDREW J. FENTON

DRESSED in hip rubber boots, heavy mackinaw, an ear-lap cap pulled down over his ears and with thick gloves on his hands in addition to his regular clothing, Jim Dugan started through the deep snow for the roundhouse at Crossover.

He was tired, lame and stiff. It was near midnight when he quit work the previous night, and now he was leaving his home at six-thirty in the morning to get back on the job, for he knew from past experience that this heavy snow would put Crossover terminal out of commission unless he got on the job early.

It was a dog's life—work, eat and sleep. What pleasure did he get out of life anyway?

Stepping on a slippery piece of ice concealed by the snow, he slipped and fell, wrenching his back in his efforts to save himself from falling. Then the pop valve blew off, for what he said is not printable. Picking himself up and wiping the snow from his face, he continued on his way in a frame of mind that spelled disaster to any one who crossed his path that day.

Going to the ash pit first, he found it plugged—tied up tight with a long string of dead engines. It took some time to straighten out this tangle before he reached the roundhouse. There, too, he found a general tie-up.

Crossover only had a 24-stall roundhouse, and it required mighty close figuring to keep business moving. It was the terminal of three important busy divisions, and the company had for years talked about erecting larger and more modern terminal facilities, but so far they had managed to worry along with conditions as they were, although far inadequate to handle the business even under normal conditions.

For nine years Jim Dugan had been general foreman at Crossover, and during that time he had become so familiar with conditions that he was able to quickly straighten out any congestion within the scope of human intelligence. He had made a reputation in handling Crossover.

It was nearly noon before he reached his office, and by this time he was dead tired. Hurriedly glancing over the accumulation of messages and correspondence, he came to one letter which made him sit up and whistle. It was a circular letter sent out from headquarters and announced that Mr. Joseph Harris had been appointed general master mechanic of numbers one, two and three divisions. Yes, the three divisions of which Crossover was the all-important apex. And Joe Harris, his old side partner, too.

His first thought was that Joe Harris was a lucky man. Then, as he again read the letter announcing the appointment, his mind wandered back to the time, 20 years ago, when he and Joe Harris started to work as apprentice boys. They both began their apprenticeships on the same day and in the same shop.

Later as mechanics they worked in the same gang, side by side. Then he had been appointed gang leader and had drifted away from Joe. Shortly after that Joe Harris had quit the road and gone to another railroad. Then they had lost sight of each other entirely. In the meantime he had stayed with the company and had been promoted from gang leader to foreman, and then to roundhouse foreman, and later to general foreman at Crossover, where he had now been for the past nine years. To be sure, he had received no sensational promotions, but he had slowly climbed the ladder of success, and if there was to be a new general master mechanic the job belonged to him by rights. He was the oldest employee and he had demonstrated his ability and loyalty on the road, so why did the company pass him by?

These thoughts filled his mind with resentment and anger. It was a fine way to show appreciation of meritorious service, holding a man down all his life, just because he could handle a terminal that no one else could handle. Several times in the years gone by there had been promotions made which rightfully belonged to him, but the officials had smoothed the matter over by either raising his salary or else bluffing him into believing that no one else could handle Crossover as he could and that he was such a valuable man at the terminal they could not move him without sacrificing the best interests of the company.

Brooding over these incidents, in addition to this last

What He Said Is Not Printable

insult, Jim Dugan made up his mind that he would quit right now before he was too old to secure a job elsewhere. Picking up a message blank he started to write out his resignation when the clerk poked his head in the office door and informed him they had just backed an engine into the turn-table pit.

Instantly Jim forgot all about his resignation, for he must get into immediate action. With the turn-table blocked his office was no place for him to be in. He must get on the job and get busy. Giving instructions to his clerk to call the wrecking crew, he rushed out to the turn-table.

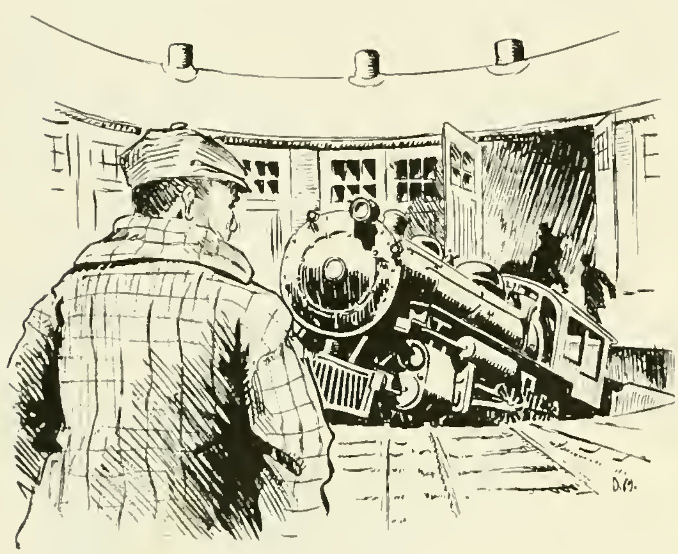
By the time he again had things moving it was mid-

afternoon. He went to his office for a little rest and, stretching out in his office chair, he prepared to take a little nap. His office was hot, close and the air stuffy, hence in a few minutes he was sound asleep.

Suddenly he was awakened by his clerk, who told him that the superintendent of motive power had just gotten off No. 4 at the depot and was headed for the roundhouse.

Picking up his gloves, he saw his partly written out resignation. What an opportunity. Now he would tell the S. M. P. right to his face that he was quitting. He would not send a message, for that would be too brief. He had a lot of things he wanted to get "off his chest," and now was the chance.

Going out through the house he met the S. M. P., and they began to talk over several routine matters. At last



They Had Just Backed An Engine Into the Turntable

they reached the office, where it was quiet, and then Jim opened up. Somehow he couldn't say the nasty things he had in his mind, but simply told the S. M. P. that he was disgusted and was going to quit.

The S. M. P. showed his surprise at what Jim was saying and finally stopped him.

"Look here," he said, "you have never showed us that you were worthy of promotion. You have been here so long that you are in a rut. What we want in a man is progress."

"Does not nine years' successful service show some progress?" asked Jim.

"In a way it does. Just stop a minute and look at yourself. You have been here nine years. During that time you have kept things moving. But they were moving before you came here. You haven't done anything out of the ordinary. If we made you general master mechanic you would take the job just as it is and you would carry it along just as it is. We need action. We need a man who can see ahead and who can do things that will cause some notice. You are a follower—we want a leader," replied the S. M. P.

"But how can I show that I am a leader, buried here in this out-of-the-way place?" asked Jim.

"There you go. That's just the answer to why you are here. You cannot see—you want some one to point the way. When I got off the train this afternoon I knew you would have business going here at Crossover. Some other fellow would be tied up tight, perhaps. In other words, he would have done something to cause notice. Of course, if always bad, we would fire him, but if something of a complimentary nature, in time we would have to promote him. Crossover moves every day the same, nothing new or startling, and you move with it—neither up nor down. Show us that you can get out of the rut and I will be the first man to shove you ahead."

There was no answer to this argument. Jim Dugan could see how true it was. He had buried himself; for nine years he had been his own worst enemy. When first he had taken hold of Crossover he had made a few half-hearted attempts to introduce new ideas, but as he had had no support from headquarters he had given up and slipped back into a rut, until now he was standing still. He would get support now.

"I will not resign, but from today on I shall act as if I had just been appointed to my present position. You are to know me not as Jim Dugan of the past nine years but as Jim Dugan with a future before him," said Jim.

"Let's shake on that," was all the S. M. P. could answer.

Jim Dugan faced a task. Many times during the next few weeks he was at the point of giving up, but he would grit his teeth and mutter, "I'll show him."

And as he progressed he began to feel ashamed of himself. Jim Dugan saw many of the little things which had escaped his notice in the past and which now loomed up big before him, as standing in the way towards successful management. He gave up taking his mid-afternoon nap—

"The S. M. P. Just Got Off No. 4"

one of the bad habits into which he had fallen. He spent less time in the road foreman's office visiting with engineers. He dug into engine failures personally. In the past his clerk had conducted such inquiries, but now he did the work. Much to his surprise, he learned a lot. He found conditions that should be corrected. He saw opportunities for new designs of equipment that would better the power. All these and many other recommendations he sent in to the head office, where they were simply acknowledged, but no action taken on them as far as he could see. But he did not

become discouraged—he kept plugging. He had made many changes at Crossover. His costs were decreasing, his men were satisfied—he was now making a record.

He heard that a certain type of engine was giving all sorts of trouble on one of the other divisions. He asked to have them assigned to his division so that he could study them. Soon he located the trouble, corrected it, and the engines were a success.

Many nights when he went home he was dead tired, but in the morning he was always anxious to get back on the job, for there was some question that always needed his personal attention. Where life had been a drudgery it was now a pleasure. He looked for engine failures with joy, for it would give him a chance to check up and conquer. But engine failures had stopped, so he turned to other things. He tidied up the place, he painted, he did a thousand and one things to place Crossover on the map—and he succeeded.

One day he received a message; "Report to headquarters tomorrow a. m.," was all it said. He wondered what it was; nothing to fear anyway.

When he reached the S. M. P.'s office he met the general manager, who greeted him with, "Hello, Jim, how does it seem to have a real job now?"

Bewildered, Jim looked to the S. M. P. for an answer. "Oh! yes, Jim, I forgot to tell you, that you are general master mechanic of numbers, one, two and three divisions," said the S. M. P. in answer to Jim's look.

"Well, I don't know whether or not I want to leave Crossover," replied Jim turning and looking at the general manager.

"Ain't that hell," said that worthy official, "it's hard to get a good man and we certainly need a man like Dugan for general master mechanic."

"Dugan will take the job, I know, for that's a little understanding we have between ourselves," said the S. M. P. as he slyly winked at Jim.

Heat Treatment of Steel in the Tool Room

Equipment and Methods for Tempering Carbon and High Speed Steel, Hardness Tests and Service Records

BY M. H. WILLIAMS

The art and methods of hardening and tempering tools, such as are made in railway tool rooms have received a great amount of attention in the last few years, and as a result there has been a decided improvement in the wearing and lasting qualities of these tools. In many cases, in order to bring about this desired result it has been necessary to change practically the entire method of handling the work.

Not many years ago it was the custom for the blacksmith to harden and temper all tools, the heat being governed almost entirely by observing the color of the tool, both when hardening and when drawing the temper. These men became very expert at their work and produced results that at the time were considered satisfactory. As the art of steel making advanced and methods of testing tools were introduced, it was found that by the older methods, even with the most expert workmen, the wearing qualities of tools did not equal the results obtainable or demanded.

The present good results may be attributed principally to the gradual improvement in furnace design, devices for recording or measuring the heat, instruments that will measure the hardness of the tool after tempering, and last but not least, the records that are made of tools when hardened, the latter giving a brief history of the kind of steel, heat treatment, hardness, etc. In the event that a tool does not stand up properly the records may be consulted and the next lot modified in the treatment to overcome the defects. These records are also valuable when a new design of tool is to be hardened, as by consulting them, data concerning tools of similar nature may be considered and the treatment arranged accordingly.

TEMPERING SHOULD BE DONE IN THE TOOL ROOM

The question of the location of furnaces for tool hardening has been the subject of considerable study. In the past it was the custom to do practically all tool hardening in the blacksmith shop, often in open forge fires. This has proved bad practice when compared with more modern methods, later investigation having sown that it is advisable to locate furnaces for this work in the tool room. In this location the work will be under the eye of the tool room foreman, which makes him responsible for the entire manufacture. This location in turn brings up the question of men for the work. On account of the different natures of tool hardening and ordinary blacksmith work it is difficult to find much similarity in two crafts. Generally there will be found enough tool hardening in railway tool rooms to justify the employment of a man for this work only, who can make a study of hardening and tempering and devote his entire time to it. This employee may have been employed at hardening by the older methods. If such a man is not available, a man entirely new at the work may be employed, who should work according to rules laid down by the foreman, who in turn may obtain practically any information desired concerning the average hardening and tempering of tools from catalogues of steel manufacturing companies, text books, or the greatest educators of all in this line, the very efficient agents who travel for the steel companies and who are always ready to give instructions as to hardening, and also to do the actual hardening and tempering for demonstration purposes. Here the value of records comes in. When an expert hardens a tool a complete record should be made at once, so that when it is necessary to harden a similar tool, all the data will be available.

To those who have not made a trial of the scheme of employing men who are not experts at this work it may appear dangerous. However, with present day methods, it is the custom of several tool-making concerns to instruct the hardener as to the time the tool should remain in the furnace, the temperature to maintain, the quenching temperature, the quenching liquid, time and temperature for drawing the temper, etc. The data for issuing these instructions is taken from card records of similar tools hardened or the sources of information mentioned above.

HARDENING FURNACES

It goes without saying that good furnaces that may be maintained at a uniform temperature are necessary if satisfactory results are to be obtained. At the present day a furnace that cannot be maintained within 10 deg. of the desired temperature cannot be considered satisfactory, and with a number of

the later designs this is obtained without any great amount of care on the part of the operator. Several makes of combined pyrometers and heat regulators are now on the market for automatically controlling the supply of gas or electricity used by the furnaces. By the use of these devices, temperatures are maintained as desired, with but little attention on the part of the operator. Where additional furnace equipment is contemplated for use with gas fuel or electricity these regulating devices should be carefully considered.

For all around tool room furnace hardening natural or city gas appears to meet the requirements better than other fuels. With properly constructed furnaces and a good supply of gas, the heat may be controlled to a nicety, and it is unnecessary to erect a stack except in very badly ventilated rooms. In some locations gas is not available, making it necessary to use fuel oil, coke or the more desirable method, electricity.

A furnace for tool room hardening, making use of any fuel, should be so constructed that the direct flame does not come in contact with the article to be hardened. This desirable condition may be accomplished by making use of a combustion chamber in which the gas and air, or oil and air, after leaving the burner and before entering the heating chamber thoroughly combine and form a hot gas, which in turn enters the heating chamber. The result, if a well designed combustion chamber is provided, will be that in the heating chamber there will not be any appearance of a flame, but simply an intense red heat surrounding the article to be hardened equally on all sides, resulting in an even heat, which is very essential. Furnaces in which the flame is visible cannot be considered satisfactory, and they should be rebuilt or renewed.

One of the very satisfactory forms of gas furnaces is constructed so that the gas and air combine in the combustion

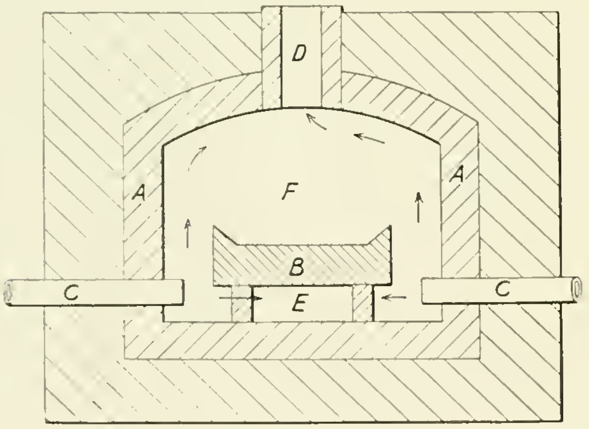


Fig. 1. Cross Section of a Typical Gas Furnace

chamber below the hearth as shown in Fig. 1, in which *AA* are the walls lined with firebrick, *B* the hearth supported from the bottom of the furnace on piers of fire brick, *CC* the burners, and *D* a vent at the top. With this furnace the gas and air after combining at the burner, enter the lower chamber *E*. This gas mixture passes up between the hearth *B* and the walls of the furnace and into the heating chamber *F*. As a result the article to be hardened does not come in contact with the direct flame. The pyrometer when used in this furnace generally enters through a hole in the rear wall. In order to properly equalize the heat it is customary to locate burners on each side.

In many cases gas furnaces not equipped with combustion chambers may be rebuilt to obtain the benefit of the lower combustion chamber by building a hearth of firebrick resting on piers of like material. Several good makes of gas furnaces are now on the market that may be purchased at reasonable prices, and it will often be found more economical to order one of these than to attempt to rebuild present equipment.

OIL FURNACES

Many railway shops are located where gas is not available. It then becomes a question of making use of fuel oil, kerosene, coke or electricity, electricity being without a doubt the best suited for the purpose. However, in cases where this can not be obtained at reasonable rates, it is often necessary to resort to other fuels.

A number of designs of oil-fired furnaces are employed. One very satisfactory type, known as the oven-fired, is shown in Fig. 2. This design has a combustion chamber *A*, heating chamber *B*, a perforated arch *C*, a hearth *D*, set above a waste heat duct *E*, and the customary roof *G*. The burner *F* is placed at the side. The walls *HH* are supported on suitable legs or built up solid from the floor. The leg construction is more desirable for small sizes generally used in tool

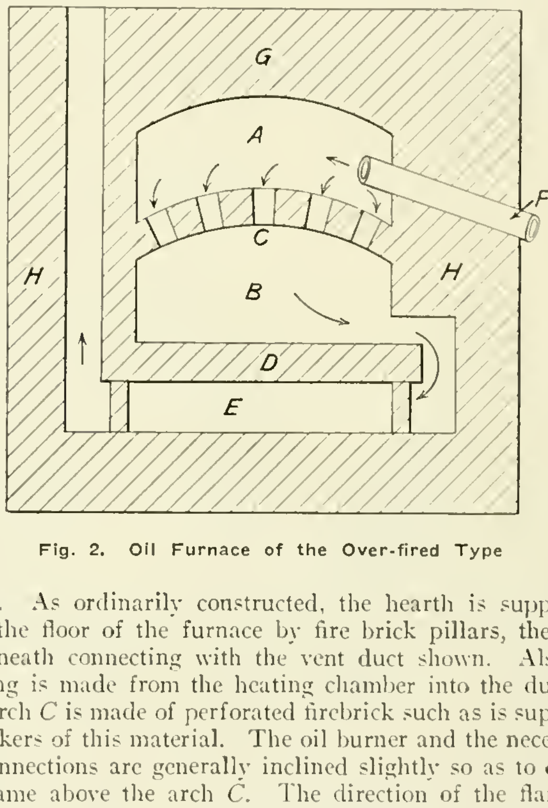


Fig. 2. Oil Furnace of the Over-fired Type

rooms. As ordinarily constructed, the hearth is supported from the floor of the furnace by fire brick pillars, the duct underneath connecting with the vent duct shown. Also an opening is made from the heating chamber into the duct *E*. The arch *C* is made of perforated firebrick such as is supplied by makers of this material. The oil burner and the necessary air connections are generally inclined slightly so as to direct the flame above the arch *C*. The direction of the flame is indicated by arrows. In the combustion chamber the air and oil after leaving the burner combine and form a hot gas that passes downward through the perforated arch and into the heating chamber in which the articles to be hardened are placed, the waste heat from the heating chamber passing through the duct *E*, which also heats the hearth, and up through the side vent. A furnace of this nature is often used without a vent to the roof in well-ventilated rooms. The pyrometer, as in the case of the gas furnace, is passed through an opening in the back wall. This form of furnace may be maintained at a fairly uniform heat, provided the supply of oil and air is regular, and will, as a general rule, be found as satisfactory an oil furnace as any design made. The consumption of oil may be somewhat greater than other forms. However, the consumption of fuel for tool hardening is always secondary to satisfactory results.

ELECTRIC FURNACES

There are a number of types of electric furnaces that are giving most excellent results for tool room hardening. In fact, the results are so very good that their installation should be carefully considered in any railway tool room where the

proper current is available. One very satisfactory type is the Hoskins, shown in Fig. 3. This is made up of a heating chamber *A*, at the top of which is placed a carbon connecting plate *B*. Two piles of thin carbon plates *DD* form the sides. These rest on graphite bottom plates *EE*, which in turn rest on the adjustable electrodes *FF*, which are controlled by the adjusting screws *GG*. These electrodes *FF* are kept cool by water circulating through the clamps *HH* and pipe *I*. The bottom of the furnace or hearth is made up of some insulating material, such as cement. The electrodes *FF* are surrounded at the lower end by asbestos packing, and at the top by sand, in order to form an air-tight seal and allow for the movement of the electrodes. All these elements are surrounded by a heavy wall made up of heat-resisting material, and as a result very little heat escapes to the room.

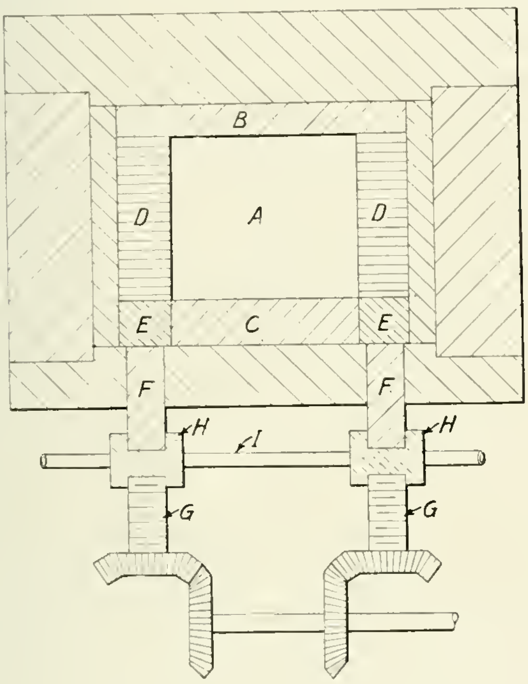


Fig. 3. Carbon Plate Electric Furnace

This furnace works on the electric resistance principle. That is, a poor passage for the electric current is purposely provided, which results in heating these conductors. Or to make use of a comparison, it is on the same general principle as the electric heater used in electric street cars or the electric flat iron. In this case the carbon plates *DD* at the sides of the furnace offer considerable resistance to the passage of the current, and as a result they are heated according to the amount of current passing and the resistance they offer, this heat being radiated into the heat chamber. The passage of the current is as follows: Starting at the right hand side, the current from a transformer is connected to the clamp *H*; it then passes through the electrode *F* to plate *E*, to carbon pile *D*, to top plate *B*, and over and down to the left hand clamp *H*, in a similar manner, and to transformer.

By varying the pressure applied to the adjusting screws *GG*, the resistance to the passage of the electric current through the carbon plates *D* may be varied, which in turn governs the amount of heat transmitted to the heating chamber. The furnace takes its current from a special transformer wound for low voltage and high current. This, however, may be connected to the regular alternating current shop lighting or power circuits. It can not be used on direct current circuits. When starting, the current is switched on and pressure on the screws *GG* adjusted to obtain the correct flow of current. When the proper heat is once obtained very little adjusting is required to maintain a uniform heat. A pyrometer is used to indicate the heat of the heating chamber, similar to the practice with oil or gas furnaces. With this furnace there is but a very small amount of oxidizing or scaling of the work, owing to the fact that the air does not enter the heating chamber. It is suitable for either carbon or high speed steel, and on account of the small amount of heat radiated from the walls, may be located in tool rooms in close proximity to other tools or workmen. It has the advantage that a chimney is not necessary.

ELECTRIC BATH FURNACE

Another design of electric furnace that has been used to a limited extent in railway tool rooms makes use of a salt bath. In this type of furnace certain grades of salts are melted by the passage of the electric current through them. The articles to be hardened are immersed in the salts similar to practices with lead furnaces. Fig. 4 shows one form of electric bath furnace. This is made up of a crucible *A*, generally of fire clay or similar heat-resisting material that is a non-conductor of the current, on two sides of which are placed electrodes *BB*. A hood with a vent to the roof is necessary to carry away the gases and fumes, which are injurious to the operators. In practice, the crucible is filled with some form of salt, such as sodium nitrate and sodium chloride for the lower temperatures, and a mixture of potassium chloride and barium chloride for temperatures generally used when hardening carbon steel, or barium chloride only for high speed steel, the proportions of these mixtures being varied to suit the conditions and temperatures required. The proportions of each are given in instructions furnished by makers of the furnace.

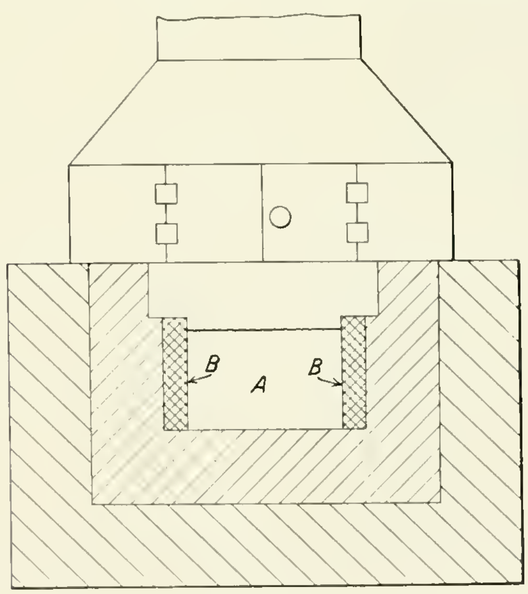


Fig. 4. Electric Bath Furnace

These salts when cold are non-conductors of electricity, but when hot, readily conduct the current. In starting, it is customary to connect a piece of electric arc lamp carbon to one of the electrodes by a wire and strike an arc in the salt near to the opposite electrode. As the salts melt, the carbon is gradually drawn away from the electrode. This forms a canal of melted salt, which conducts the current. With the current once started across, the entire mass soon becomes liquid. It is customary to keep the furnace hot at all times, which is accomplished by allowing a small amount of current to flow during the night or when not in service. The electrodes *BB* are made from pure wrought iron and are led in over the top of the crucible and down into the salt bath. These are connected to the secondary of a special

transformer, that is arranged with suitable taps and switches so that the required amount of current may be obtained, the current being shown by an ammeter. The temperature of the bath is ascertained by a pyrometer, the fire end of which is placed in the salt bath.

The work to be hardened is hung on wires and immersed in the bath and rapidly takes the same temperature. After immersing a sufficient length of time to insure complete penetration the work is withdrawn and quenched in the usual manner. Or in case of special intricate pieces they are allowed to preheat on a shelf above the bath before being placed in the solution.

This form of furnace is especially useful for carbon steel and has several good points, of which the following may be mentioned. On account of the exclusion of air from the piece while it is immersed in the bath there is no oxidation, and when it is removed from the bath a thin film of salt adheres to the surface. As a result, pieces hardened show no signs of scale. This is very desirable, for taps, dies, gages and special tools. On account of the large mass of heated salts, the furnace does not cool down to any great extent when work is placed in it. For carbon steel it gives most excellent results and is to be highly recommended. For high speed steel it is necessary to renew the electrodes at frequent intervals, and it becomes a question of whether this furnace is a paying proposition. Before installing, it is advisable to look into the question, as the art of heating by electricity is advancing so fast that it is dangerous to say one day what will be done in the next.

This furnace, like the one previously explained, gives out very little external heat, and can therefore be placed in tool rooms. On account of the fumes, a chimney must be provided.

BATH FURNACES OR LEAD BATHS

Certain long articles which are made in railway tool rooms, such as stay-bolt taps, taper frame bolt reamers, etc., cannot

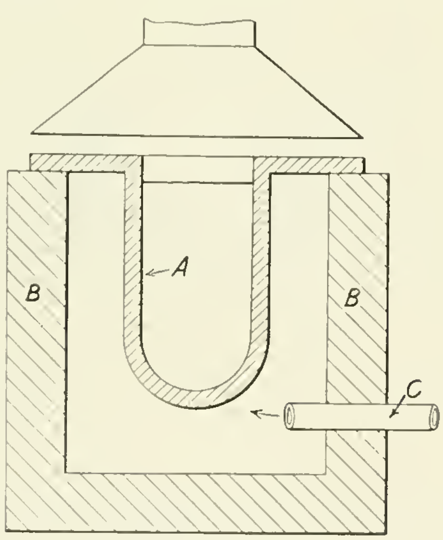


Fig. 5. Lead Bath for Heating Tools

well be hardened in the customary tool-hardening furnaces without constructing them too large for the average demands. Also, on account of their comparatively great length, it is difficult to obtain a uniform heat over the entire tool in the average furnace. To overcome this difficulty the lead bath or salt bath is employed. As a general prosposition, of the two methods the lead bath appears to meet the requirements better, all things being considered.

One form of this furnace is shown in Fig. 5, where *A* is the pot, which for use with lead is generally made of cast iron or seamless steel tubing closed and welded at the lower end and flanged at the top to rest on the brick casing. The seamless tubing construction is much preferred on account of its longer life. The circular brick work *BB* forms the wall of the furnace, and is lined with firebrick, the diameter of the inside being sufficient to allow the flame to readily pass around the pot. A burner *C*, that may be used with gas or oil, is provided, that directs the flame below the pot. A hood *D* for carrying away the fumes given off by the lead is quite necessary on account of the poisonous nature of these fumes, although by keeping the top of the lead covered with powdered charcoal the fumes are very much reduced. A pyrometer is generally placed in a vertical position in the pot, care being taken not to allow it to touch the pot.

In practice the pot is filled with lead or some suitable salt, such as a mixture of barium chloride and potassium chloride, and heated to the required temperature as indicated by the pyrometer. Articles to be hardened are immersed in the bath and allowed to remain until heated to the same temperature as the bath, when they are withdrawn and quenched in the customary manner.

There is always the possibility where lead is used of small particles of lead adhering to the surfaces, which interferes with the proper hardening of some tools, such as staybolt taps, by reason of the cooling medium, such as water or brine, not reaching the steel, resulting in soft spots. To guard against this several methods are employed, one being to paint the article with a mixture of common whiting and wood alcohol, or whiting and water. If the latter is used it is necessary to dry the piece thoroughly, otherwise the lead will fly and may injure the operator. With the salt bath this is not necessary.

There are a number of advantages to be gained by the use of the lead bath furnaces as compared with ordinary gas or oil-fired furnaces. On account of the entire absence of air surrounding the tool while hardening there is no scaling. This is very essential for taps. On account of the large volume of lead the temperature can be maintained within close ranges and is very little affected when placing cold pieces in the bath. In addition to taps these furnaces are used quite extensively for hardening drills, reamers, flue tools, chisels, etc. For articles like chisels and rail cutters, where it is desirable to heat only a part of a tool, the lead bath gives most excellent results, and is so much superior to the ordinary open fire as to warrant its installation for this purpose only. Therefore, it may be said that no railway tool room is complete without the lead or salt pot furnace.

SCALING OF TOOLS DURING HARDENING

Scaling or oxidation of tools during the hardening process is objectionable, especially where they are of a nature not admitting of grinding after hardening, such as taps, gages, etc. This scaling follows as a result of air or oxygen entering the heat chamber and being absorbed by the steel while at the higher temperatures. With practically all forms of furnaces, with the possible exception of the salt or lead bath, a certain amount of scaling is bound to take place while the tools are in the furnace and during the short interval between removing from the furnace and quenching. Proper regulation of the air used with gas or fuel oil will have the effect of reducing the amount of scale. In order to approach the desired results it is necessary to obtain as nearly perfect combustion as possible before the flame enters the heating chamber. This is accomplished to a greater or less degree by proper regulation of the flow of air along with the fuel used. This makes a uniform pressure of air very essential. The use of air from the average blacksmith shop blower line is objectionable on account of variations in pressure, resulting from the intermittent use of forge fires. High pressure air, such as is used for air hammers and similar tools is also not to be recommended on account of uneven pressure and from the cost standpoint. Where this

must be used the conditions may be improved by the use of suitable reducing valves between the shop line and the burners which, let us say, will reduce the pressure down to 20 lb. This will give a uniform pressure at the needle valve of the burner even if the shop line pressure varies.

Where possible, a separate fan should be installed for tool room furnaces. In order to obtain proper combustion with gas or oil a pressure of about 10 ounces should be available. This is generally greater than the average blacksmith shop line. Where fuel oil is used it is also necessary to obtain a uniform pressure in order to feed the burners at a uniform rate. This may be accomplished in most cases by erecting a stand pipe or tank near the furnaces.

Furnaces for this work should be kept as tight as possible both in the walls and doors. Special care should be given the latter, as in the event of air entering, the scaling will be increased. One very good scheme to insure a tight door is to build the door side of the furnace on a slight incline, say about 10 deg., and hang the door to slide against this surface. With proper hanging for the door it can be so arranged that when down it will make a very good surface contact with the furnace, and when lifted will draw away from the wall. With this form there is no need for guides for the door, on account of the door only resting against the furnace. In the event of an explosion or puff of fire the door is blown outward without other damage. It is now customary to provide all furnace doors with self-closing peep holes. By opening these the temperature of the articles in the furnace may be judged by comparing the color with the pyrometer fire end. That is, when the tool and the fire end are one color both are at one temperature, a slight variation being quite noticeable when looking at both at one time. However, the fact that the tool on the outside is of the proper temperature does not indicate the time to quench, for in order to insure proper hardening the tool must remain in the furnace long enough after the outside is of the proper temperature to insure complete and uniform penetration of the heat all the way through.

FURNACES FOR TEMPERING OR DRAWING BACK

The oil bath and electric furnace, or electric oven as it is more properly called, are now largely used for drawing the temper of tools. By the use of either, very satisfactory results are obtained, this method being very much superior to drawing the temper by observing the color of the tool.

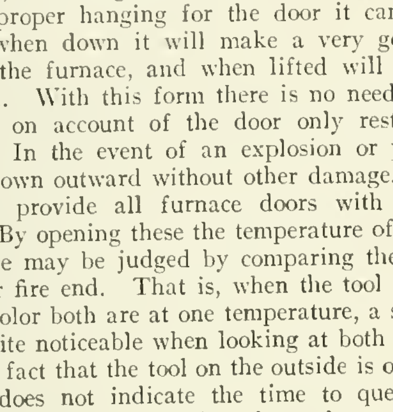


Fig. 6. Oil Pot for Drawing Temper

The oil bath form shown in Fig. 6 is made up of a cast or wrought iron pot resting on a circular brick or cast iron wall or stove. Underneath the pot the necessary burners are placed for use with oil or gas, according to the fuel available. The pot is filled with a special grade of high fire test oil sold for this purpose by concerns making a specialty of these oils. The pot is provided with a hinged cover arranged so that it may be closed instantly in the event of the oil firing, when the closing of the cover smothers the flame. A glass bulb thermometer is generally suspended in the oil for the purpose of indicating the temperature. As it is often the practice to draw the temper of a large batch of tools at one time a chain block is often placed above the furnace for the purpose of lifting the baskets in which the tools are held out of the pot.

In practice several pieces of a similar nature which may be the result of a day's hardening are placed in the perforated basket and lowered into the oil bath, preferably when the oil is at a low temperature, say below 200 deg. F. The oil is then gradually brought up to the required temperature and held at this temperature from one to three hours in order to insure that all pieces assume one temperature and that the heat penetrates all the way through. The basket is then withdrawn and the work allowed to cool in the air. Placing the tools in the oil when it is comparatively cool eliminates the possibility of setting up local strains in the previously hardened tools and reduces the breakages as compared with placing the hardened tools in a furnace that is at a high temperature.

ELECTRIC DRAWBACK FURNACES

This form of furnace is now used quite extensively for temper drawing. Generally they are made up of a heating chamber very similar to regular hardening furnaces, the chamber being enclosed by firebrick or heat insulating material. The door is generally hinged on one side and made to fit very closely into the opening, being locked in a manner similar to the practice with stoves. The heating units, which are made up of electrical resistance wire, are placed at the sides of the heating chamber. The passage of the current through these units causes them to give off heat that in turn heats the oven. The heat is controlled by suitable rheostats or switches, and in some cases a thermostat is arranged to automatically control the heat to whatever degree it may be set. When the furnace comes up to the desired heat some of the heat units are cut out or resistance is added, which automatically controls the temperature to the required degree without hand control. In practice the work is placed in the oven and the temperature gradually brought up to the required heat and held there for the correct amount of time.

This form of furnace has several good points, of which may be mentioned the almost entire absence of heat in the room, a uniform temperature under good control, absence of smoke or smell, safety, and when provided with a thermostat, a uniform heat is obtained without hand regulation.

These oil bath and electric drawback furnaces have many advantages compared with the older methods. On account of the slow rate of heating there is not the danger of causing a fracture in the steel, and the heat penetrates to the center and insures uniformity throughout the piece. This is of particular value when drawing the temper of a piece of irregular shape or section. The method is much cheaper, as a large number of pieces may be drawn at one time without more attention than watching to insure the correct temperature. There is also a considerable saving on account of avoiding the necessity for brightening the work.

The temperatures agreeing with the various colors generally used for drawing back are as follows:

	Deg. F.	Deg. C.
Very pale yellow	430	221
Light yellow	440	227
Pale straw yellow	450	232
Straw yellow	460	238
Deep straw yellow	470	243
Dark yellow	480	249
Yellow brown	490	254
Brown yellow	500	260
Spotted red brown	510	266
Brown purple	520	271
Light purple	530	277
Full purple	540	282
Dark purple	550	288
Full blue	560	293
Dark blue	570	299

This table will serve to connect the various colors and temperatures. However, on account of the fact that heating in an oil bath or an electric oven is quite a different operation from drawing by colors, a certain amount of experimenting is often necessary in order to determine the correct temperature and time the tools should remain in the drawing furnace. When this information has once been obtained the results may be duplicated with great accuracy, and if shown on card records it should not be difficult for a person not familiar with hardening to obtain satisfactory results. This is much to be preferred to relying on some one man for this work.

PYROMETERS

The great advances in the art of hardening and heat treating of steel that have been made may be attributed very largely to the pyrometer. In fact, it would at the present time be almost impossible to get along without this valuable instrument. Any tool hardening plant without these is very much out of date.

Pyrometers are so universally used that a lengthy description cannot be considered necessary. The principal part of this outfit is the indicator, which is constructed as far as the working part is concerned very similar to volt meters, practically the only change being the size of wire used and the graduation of the dial, which is graduated for degrees Fahrenheit or Centigrade instead of volts or amperes. The thermocouple, or fire end, is generally made up of two wires, each of a different composition, the two being welded together at one end and connected at opposite ends to wires leading to the indicator. The wires making up the fire end are enclosed in a metal or porcelain protecting tube to prevent the direct heat coming in contact with the wires. When the joined ends of the fire end are heated a very feeble current of electricity is generated, which is indicated by the needle of the indicator. The scale of the indicator is graduated by the makers to read in degrees of heat according to the heat at the fire end. These fire ends, on account of continued heating, will wear out, for which reason it is customary to purchase several with each instrument. They are now made of two classes, one being known as base metal, made from steel wire or alloys, which are suitable for temperatures up to about 1,700 deg. F., and used very largely when hardening carbon tool steel or casehardening. These are not expensive. For higher temperatures, such as are necessary for high speed steel that may go as high as 2,400 deg. F., it is necessary to employ fire ends made from platinum and platinum-rhodium or similar metals. These are very expensive and can only be recommended where it is necessary to harden expensive high speed tools.

Pyrometers, like any delicate instruments, are liable to get out of order if abused or not given proper attention. It is customary to encase the indicator in a protecting case to exclude dust, and it should be mounted on a firm wall or support. This part of the pyrometer outfit is so well made that trouble rarely occurs. The thermocouple, or fire end, when made of any metal is liable to errors, and must be frequently calibrated in order to insure accuracy. The question of calibration will be considered later.

A pyrometer can be installed by the regular shop electrician who follows the instructions given with the instrument. The indicator should be located out of range of the direct heat of the furnace. The wires are generally run in conduit similar to lighting circuits. The fire ends are generally passed through the back wall of the furnace, a hole being made for that purpose. The fire end should not be removed except when making calibrations. Good practice generally indicates that a separate indicator should be used with each furnace, in which event they are banked on a suitable board secured to the wall of the building. By this method the temperature of all furnaces is under the eye of the hardener at all times.

For certain classes of service recording pyrometers are used. These make a record of the temperature very similar to the records of air and steam pressure in power plants. It is a question whether these are necessary in tool rooms where this work is under the eye of an expert.

There are a few points in connection with the use of pyrometers that should be carefully observed, one of these being the case of the hot and cold ends of the couple. The amount of current generated and the movement of the dial needle depend on the difference in temperature of the hot end, which is placed in the furnace, and the cold end, which is the opposite end of the couple. Generally these couples and dials are graduated to read correctly when the temperature of the cold end is at the average room temperature, or about 70 deg. F. If the cold end is too close to the furnace and its temperature is raised, the readings will be affected accordingly. That is, if instead of 70 deg. it is 100 deg., the readings will be 30 deg. low.

In order to overcome this difficulty it is now found to be good practice to run the wire connecting direct to the fire ends downward to the floor, on account of this location being little affected by heat from the furnace. One method followed with good results is to use wires from the outer end of the fire end to the floor, made of the same metal as the fire ends and join the copper wire to them in a junction box located at the floor, this junction box being similar to that used for electric wiring. This results in making a very long fire end where the cold end may be kept away from the heat of the furnace. Where this practice is followed great care is taken to secure good joints between the wires of the fire ends and the extensions.

Another method followed is to run the wires of the fire end, after leaving the furnace, in conduit, and surround this conduit by a second pipe, through which a stream of water flows which keeps a uniform temperature at the cold end.

It may now be well to consider what is to be gained by the use of pyrometers as compared with the older method of judging the heat by the eye. Books issued by known standard authorities on the subject of tool steel all call attention to the importance of correct temperatures when hardening and tempering tools. The more careful steel making concerns employ chemists and test department experts who make a business of testing tool steel in order to ascertain the correct temperature when hardening, in order to obtain the greatest strength, wearing qualities or resistance to shock and also grade the steel according to the use intended. The information obtained by these concerns is generally shown in their catalogues or can be obtained by letter, the most approved methods of treatment being set forth. This information will show that practically every different tool requires a different treatment and grade of steel in order to obtain the best results.

Steels that are similar in general make-up and trade name, but differ in carbon content, must be treated differently. The higher the carbon the lower the heat required. To take an actual case of one grade of tool steel. If .100 carbon it should be hardened or quenched from 1,350 deg. F. The same grade of steel but with .060 carbon should be quenched from 1,400 deg. F. This may not appear to be a very great difference. However, quenching only a few degrees from the correct temperatures will affect the wearing qualities of the tool and may result in one tool of a batch standing up well and another made at the same time from the same bar failing.

Generally speaking, in order to obtain the best results carbon tool steel should be quenched just after reaching the so-called decalescence point, which is a heat where the steel changes its nature. Or, in other words, the steel has

changed, and by quenching is held in this changed state. One peculiar property of steel is that at the decalescence point it becomes non-magnetic. Going to a higher heat will not improve conditions or make the steel enough harder to be of value. In fact, the results will be the reverse, as a higher heat will result in a coarse grained steel, which is always an indication of poor steel or treatment. Again, practically all tools must have the temper drawn after hardening. This being the case, nothing is to be gained by overheating the tool when hardening and drawing back this extra hardness in the tempering operation. Reasoning will indicate that the tool should only be heated just hot enough to harden it properly. In order to determine the proper heat it is necessary to be governed by reliable pyrometers.

For the purpose of ascertaining the drawback or tempering heat where furnaces are heated by a flame the regular pyrometer may be used. This method of procedure is but little followed at the present time.

For the electric oven and oil bath drawing, the glass bulb thermometer is now largely used. These are of special construction for the purpose, and are enclosed in a suitable protecting casing to prevent injury in case the articles being drawn strike the casing. These thermometers are made with a scale reading high enough for all ordinary drawback temperatures.

When used in an oil bath the bulb is immersed in the oil, or when used in an oven an opening is made in the wall through which the thermometer passes. These thermometers are generally very reliable and have the advantage that they will not change with age. However, even with the greatest care the glass will at times break, therefore it is always advisable to have an extra one on hand.

A study of the table of temperatures and corresponding colors that has been given will show the small difference in temperature between colors used when following the old method of tempering and will also serve to illustrate the necessity for accurate temperature readings and maintaining the oil bath and the oven at the proper temperature.

TESTING AND CHECKING PYROMETERS

A pyrometer to be of value must be properly calibrated and kept in order and a number of methods are followed for this checking. One way is to compare the work instruments with a standard instrument kept for checking purposes only. In this event the standard instrument is generally of the portable kind that may be carried where required. When used, the fire end of the standard instrument is placed in the furnace close to the work fire end, and when the two are of the same color, as may readily be detected by the eye, i. e., the same heat, the check and work pyrometer readings are compared. If they do not agree the work instrument is tagged, showing the amount high or low. The hardener then makes allowances to compensate for this error. In case the fault is in the indicator, this part may be repaired by the maker, or if an expert on this work is available adjustment may be made locally. This work, however, can only be done by an expert. Where a number of pyrometers are used about a shop a high class standard check pyrometer will be found to be a good investment.

Where the shop is not large enough to warrant a standard check pyrometer other means of checking are followed, one method being to compare the pyrometer with the thermometer used in the oil bath. This is done by immersing the fire end in the oil bath alongside of the thermometer and comparing readings. This will check up to the limit of the heat of the oil, which is rarely over 650 deg. F. This method is fairly accurate, as the glass thermometers are generally correct within a small error. It has the disadvantage that the pyrometer is not tested at the average working temperature for carbon steel, which is generally between 1,350 and 1,450 deg. F., and if the indicator is in error the chances are that the reading will not be correct at the higher readings. However, one of the principal causes of error is the gradual wearing away of the fire ends, owing to heating and cooling, and as a test of this nature will show these errors, and can be made very quickly, it is recommended as a frequent check.

Certain minerals and salts are known to have a clearly defined freezing point, or, in other words, the point where it hardens, just as water freezes at 32 deg. F. One of the most reliable substances is salt, which freezes at 1,472 deg. F. This temperature is close to the average hardening point of carbon steel, and is therefore often used. A very satisfactory method of testing the accuracy of a pyrometer with salt is as follows: For the purpose of melting the salt a graphite crucible should be used when it can be had. Suitable tongs or bale should be provided for lifting it in and out of the fire. As a makeshift a sort of deep frying pan may be used that can be made from steel as follows: A four-inch bar of steel five inches long is drilled about four inches deep with a three-inch hole, a handle being welded to it. These pots are then filled with salt and placed in a furnace or forge fire and heated until the salt melts. The fire end is then placed in the melted salt and allowed to remain there while over the fire until the salt and fire end are of the same color and heat. This may take several minutes, the fire end being connected to the indicator while this is going on. The pot and fire end are now removed from the furnace and allowed to cool. As the salt cools readings should be taken each 10 seconds, or, better still, a curve made on cross-section paper, the temperature being set down on horizontal lines and the time on the vertical lines. When the salt freezes the needle of the pyrometer will remain stationary for a few seconds, this freezing point being clearly defined and can be detected very readily. After a few seconds the needle will again go backwards. The pot should then be placed in the fire and heated to remove the fire end, after which the salt should be washed off as it is injurious.

It is important that the cold end of the fire end be kept at the room temperature while this test is being made. If the pyrometer reading differs from 1,472 deg. F., the instrument is tagged accordingly. It is necessary to obtain pure salt for the purpose of making this test. Generally the common grade known as table salt will be found reliable. However, where there is a laboratory in connection with the shops it is advisable to obtain salt of known purity from that department. In any event, the salt must be kept clean and free from other impurities which will affect its freezing point.

QUENCHING TANKS

In order to properly harden the great variety of tools such as must be made in these tool rooms several quenching tanks are necessary, all of which must be of ample size in order to guard against a too rapid heating of the quenching solution and to maintain a uniform temperature of the liquid. Unless this solution is maintained at the correct temperature the variations will have a marked effect on the hardening. Generally speaking, tanks 36-in. by 36-in. by 36-in. of 1/4-in. material, preferably with seams welded, meet the requirements in a very satisfactory manner. These should be provided with hinged covers that may be closed when the tanks are not required, in order to keep out dirt and foreign matter.

The following quenching mediums are recommended: clear water, salt water or brine, and oil. For the larger rooms it is advisable to install two tanks for each of these solutions in order to be able to alternate from one to the other as the solution becomes warm. In many cases cold water or steam pipes, or both, are placed in these tanks for the purpose of maintaining a uniform temperature. By

making proper use of the water or steam the liquid can generally be kept near a uniform temperature. As an illustration of the value of this, suppose it is necessary to harden a large batch of tools at one time similar to flue tools. If proper provision is not made to maintain a uniform temperature of the water or oil used the first of the tools quenched in the colder solution will be the harder, and while this may not be a very serious question, it is desirable to harden all tools of a batch alike, and as this can be accomplished readily by the use of proper cooling coils it certainly is worth while making provision for them. For some classes of hardening, especially nickel steel, it is often necessary to warm the water to possibly 200 deg. F. in order to prevent too rapid cooling. The same holds good where it is necessary to harden a piece of irregular section or where there are a number of sharp corners where warming the solution will prevent cracking the piece quenched.

The location of tanks with reference to the furnaces is also important. Where possible it is advisable to place these all in a row facing the furnaces with a space of some six feet between.

When hardening articles having concave surfaces similar to drop forging dies, or hollow articles such as hollow mills used on screw machines, it is advisable to equip one tank with a nozzle or spout which may be made of gas pipe loose jointed to enable the stream to be changed to meet different conditions. When hardening, the stream can be directed on the surface requiring the hardest surface to insure proper results.

In addition to the quenching tanks an air blast for high speed steel hardening should be provided. The mistake should not be made of using compressed air from the shop line without a reducing valve to cut down the pressure.

THE SCLEROSCOPE

No tool room can be considered complete without a scleroscope, this being an instrument for measuring the hardness of metals. It was the custom at one time to test all tools after hardening with a file. This was a rough and ready method that would tell when a tool was too soft but would not indicate when it was too hard or how much too hard or too soft. By the use of the scleroscope the exact hardness of any tool may be measured with great accuracy. This makes it possible to test the hardness of tools, and in case they are not correct, to modify the method of hardening and tempering.

This instrument works on the principle that if a weight that has been very carefully made as regards size, weight and shape of point be dropped from a uniform height the rebound of the weight when striking any substance will be governed by the hardness of the substance hit. This can best be illustrated by a homely comparison of dropping a marble. Suppose a marble is dropped on a wooden floor. The rebound will be a certain amount. If the same marble be dropped from the same elevation on a concrete floor the rebound will naturally be much greater on account of the increased hardness of the concrete as compared with the wood floor. This same principle is used in the scleroscope, which is so constructed that the weight will always be dropped from a certain predetermined height. By observing the height of the rebound on the scale the actual hardness of the metal is determined.

This instrument, which is shown in Fig. 7, has a glass tube *A*, with a scale graduated to 140 equal divisions much like a thermometer. Inside this glass tube is placed a small weight having a sharp-pointed diamond set in the bottom, this weight being free to move inside of the glass tube. For the purpose of raising the weight the soft rubber bulb *B* is squeezed and then released. The vacuum above the weight lifts it to the top of the tube, where it is caught by a catch in the round cage at the top of the instrument. When the bulb is pressed the second time the weight is released and falls, striking the object to be tested, and then rebounds, the amount of rebound being noted on the scale, which may be easily read. This rebound may indicate 40 for soft steel, 60 to 70 for the ordinary chisels and flue tools or possibly as much as 100 for extra hard tools. A magnifying glass, as shown, is employed, which assists when making close readings.

The instrument is leveled by leveling screws *E* and may be raised or lowered by turning the knurled nut *F*. The rod *D* acts as a plumb bob to show when the glass tube is perpendicular. Small articles are placed on the platform *G*. The glass tube is then lowered by means of the nut *F* until

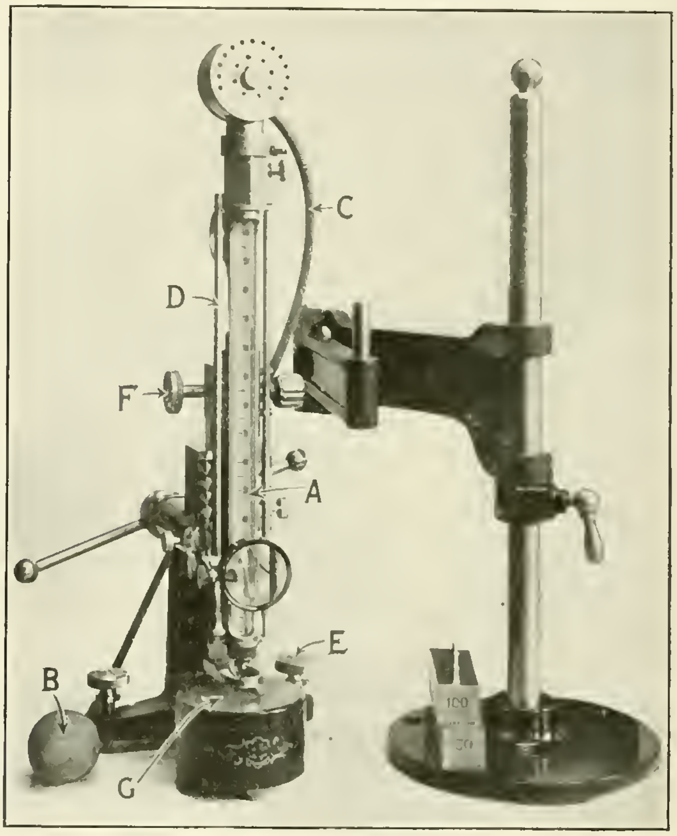


Fig. 7. The Scleroscope

the metal at the end of the glass tube rests on the piece to be measured. The weight is then raised, allowed to drop and the amount of rebound measured.

When it is necessary to test articles that are too large to go on the platform the instrument is held in a swinging bracket and located above the point where the tests are to be made. In this event, it is customary to hold the article in a vise or rest it on the work bench or an anvil.

The graduations on the glass tube have no particular meaning. However, they are similar on every instrument made. Therefore, readings made from any instrument will be alike when measuring the same hardness of steel. This makes it possible for one shop or the engineering department to instruct other shops having similar instruments as to the hardness of tools and also to compare results from time to time.

This instrument should be used for testing the hardness of each tool made in the tool room. The result will be that tools not properly hardened will not get into service. A record should also be made of each tool or batch of tools. From this the tool room foreman can tell just how hard a tool was made. If it has stood up well the hardness may be set as a standard and future tools hardened and drawn to

the same degree. If a tool when in service was found too hard or too soft the next ones made can be varied to meet requirements, the records being consulted to find the hardness of the defective tools. As an illustration, take the case of a flue beading tool. This should not be too soft or the throat will batter up; or too hard, as it will break. The scleroscope will measure this hardness, which for this tool should be between 60 and 70, as shown on the scale. Cutting tools, such as drills and taps, are generally harder and may show 80 to 90. This instrument is very valuable for high speed tools, as an expensive high speed tool, such as a milling cutter, drill or reamer, may be readily broken if too hard. The mistake is often made of not properly drawing the temper of these tools under the impression that high speed steel must be very hard. The scleroscope will detect where these tools are too hard and often prevent costly breakages.

In many shops it is the practice to test each tool made with this instrument in order to pick out tools that may not have been properly hardened and which is also a check on the entire operation of hardening, tempering and grade of steel. To make this test it is customary to grind a smooth surface on the tool, which may be done on a wheel or by hand, and make the test on this ground surface, the actual preparations and testing only requiring a few seconds. The knowledge that all tools leaving the shop are correct and detecting and rehardening the defective parts very much overbalances the cost of making the tests.

RECORDS OF HEAT TREATMENT

A card record of tools made in tool rooms will be found of great value. On these cards may be recorded the more important points concerning the various tools manufactured, such as the name of tool, blue print number, maker and grade of steel, temperature to which heated when hardening and time in furnace, quenching medium, whether tool was cooled in clear water, brine, oil, etc., drawback temperature and time in furnace or oil bath, scleroscope hardness and, last but not least, space should be provided in which to record the general behavior of the tools, a sample form of card being shown in Table I.

Table I. Typical Form of Tool Record

Tools. Record of Heat Treatment.

Article .. ..

Shop used in..

Make of steel ....

Trade name or mark..

Carbon ....

Harden at degrees F .. ..Quench in..................

Draw degree F....... ....Quench in..................

Scleroscope Hardness..

Remarks ....

(Over)

Where a record of this nature is kept it may be consulted to show the entire history of the tool. As an illustration, take the case of staybolt taps. A lot made may wear too rapidly when in service. The card index covering the taps in question may be consulted and the probable cause of the defect determined. This may show a scleroscope hardness below 65, indicating that too high a heat was used when drawing the temper or other causes. If some of the lot of these taps are on hand that have not been used, they may be rehardened and drawn to the correct degree of hardness. If, after the second treatment, the taps hold up in a satisfactory manner it will be an indication that the correct hardness has been arrived at, which would then be a subject of record.

A record made of tools purchased, such as the name, date, maker, hardness, etc., that stand up well in service, is also of value for consultation when making similar tools. Take the case of the staybolt tap. If necessary to make these in an emergency or to recut them to a smaller size, the record of satisfactory taps will at once indicate the proper degree of hardness.

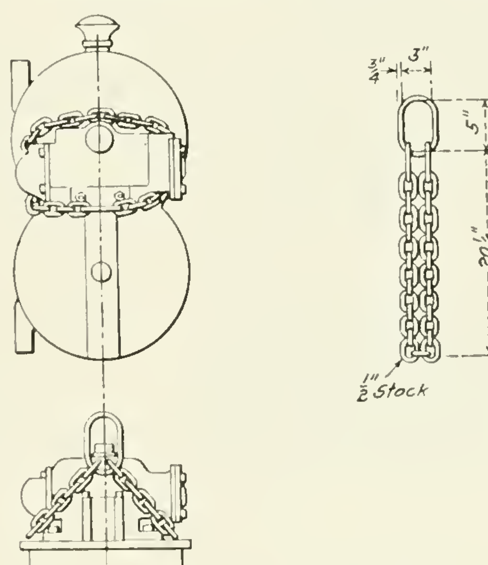
One class of tool largely used is the bridge reamer, required for steel car repairs. In order to properly stand up these must be of the proper hardness. If too hard excessive breakages will result, or if too soft rapid wear will follow. By recording the hardness of a number of these and noting results, a standard of hardness may be arrived at. Or if these are purchased it will be found advisable to test for hardness before placing them in use, and record the results. In the event that they have not the proper hardness the matter can be taken up with the manufacturers. During times of close competition it is advisable to let the manufacturers of tools know that the grade of tools is being watched, both for the good of the railway shop and also for the manufacturer, as the latter will generally welcome any criticism that may lead to the betterment of his product. Where it is possible to go back to the manufacturers with a statement of facts that satisfactory tools average, say, 70 on scleroscope reading and that the defective parts showed only 60, the statement will carry weight.

For ordinary tools, such as chisels, rail cutters, etc., the record of hardening and scleroscope is of value and well worth keeping. For the less frequently made tools, such as milling cutters, the records are of especial value. Where these tools have once been made and the data recorded, it is always possible to consult the record when a new tool of a similar nature is to be made. The previous method can then be followed if the tools were satisfactory, or modified in order to overcome any error. This record is of particular value for high speed steel cutters and various other tools made from this material on account of the high cost of the steel, and guards against the mistake often made of allowing too hard tools to go into service.

COMPRESSOR LIFTING CHAIN

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

In removing and applying the Westinghouse 8½-in. cross-compound air compresor, the chain shown in the illustration



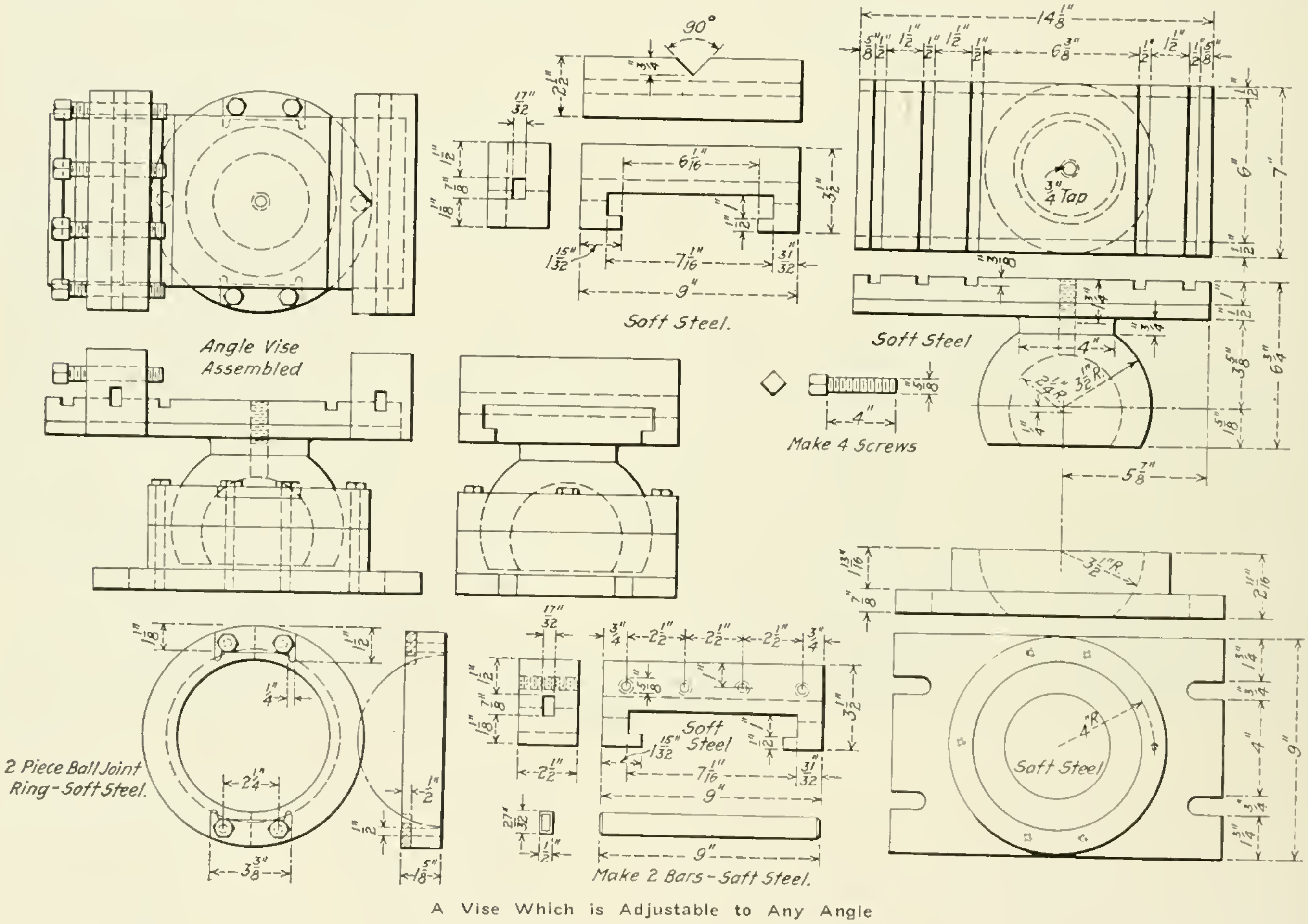
Chain Sling and Method of Attachment

will be found very convenient. The chain is made of ½-in. stock of the strength indicated, the ring at the top being made

of ¾-in. stock. In operation the chain is slipped over the top of the compressor around the valve chamber, as shown. The hook from the crane or chain block is then hooked into the large link, and when tightened up the chain is drawn around the valve chamber in such a way that it cannot slip. The compressor balances nicely, and it is comparatively easy to adjust the compressor so that the bracket bolts can be readily applied.

BALL JOINT VISE FOR DIE SINKING

Few railroad shops possess special die sinking equipment, and for that reason the vise shown in the accompanying drawing will be found especially useful. The adjustable jaws have a range to 9⅞ in. The ball can be swung through an angle of 45 deg. in any direction and is clamped by tightening the bolts holding the upper ring. The hand work involved in making dies can often be greatly reduced by the use of this vise, as the parts can be securely held at the proper angle to permit as many operations as possible to be performed on machines.



A Vise Which is Adjustable to Any Angle

RULES FOR AUTOGENOUS WELDING

The following rules adopted by the Committee on Standards for the purpose of preventing the use of autogenous welding for purposes for which it is not well adapted, have been sent to the regional directors by Frank McManamy, assistant director of the Division of Operation, with instructions to direct all roads to observe the rules in the construction or repair of locomotive boilers, so that any failures which may have been caused or contributed to by unrestricted or improper use of autogenous welding may be prevented.

The Committee on Standards, after carefully investigating the use of autogenous welding in connection with the construction and repair of locomotive boilers and fireboxes, has, in the interest of safety and efficiency, adopted the following rules:

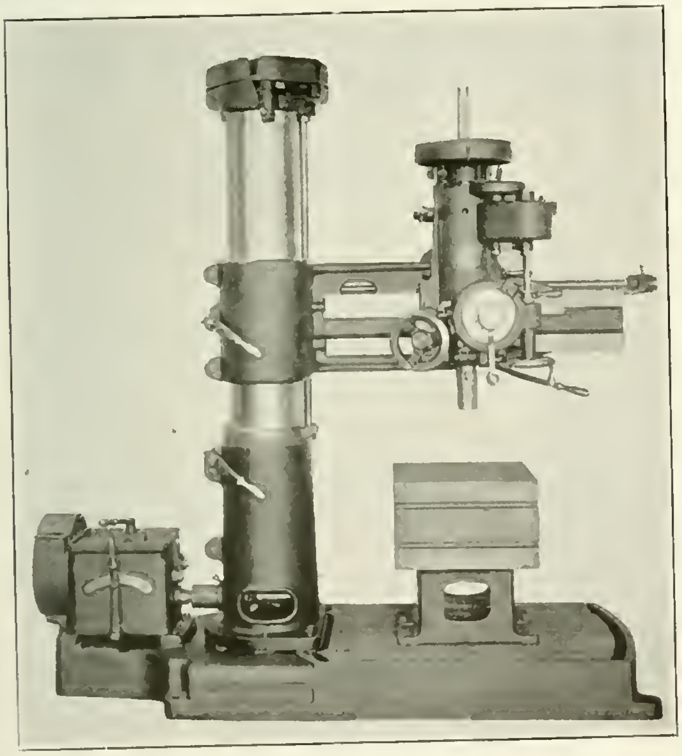
1. Autogenous welding will not be permitted on any part of a locomotive boiler that is wholly in tension under working conditions; this to include arch or water bar tubes.
2. Staybolt or crown stay heads must not be built up or welded to the sheet.
3. Holes larger than 1½ in. in diameter when entirely closed by autogenous welding must have the welding properly stayed.
4. In new construction, welded seams in crown sheets will not be used where full size sheets are obtainable. This is not intended to prevent welding the crown sheet to other firebox sheets. Side sheet seams shall not be less than 12 in. below the highest point of the crown.
5. Only operators known to be competent will be assigned to firebox welding.
6. Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.
7. When repairing fireboxes, a number of small adjacent patches will not be applied, but the defective part of the sheet will be cut out and repaired with one patch.
8. The autogenous welding of defective main air reservoirs is not permitted.
9. Welding rods must conform to the specifications issued by the Inspection and Test Section of the United States Railroad Administration for the various kinds of work for which they are prescribed, which specifications will be issued later.

NEW DEVICES

MORRIS RADIAL DRILL

A well proportioned radial drilling machine which up to its capacity is capable of pulling high speed drills at their maximum speed, has been placed on the market by the Morris Machine Tool Company, Cincinnati, Ohio. This machine is of rugged design, easy to operate, due to conveniently located control levers and can be used to good advantage in drilling, tapping, facing and counterboring operations.

The column construction does not vary greatly from standard

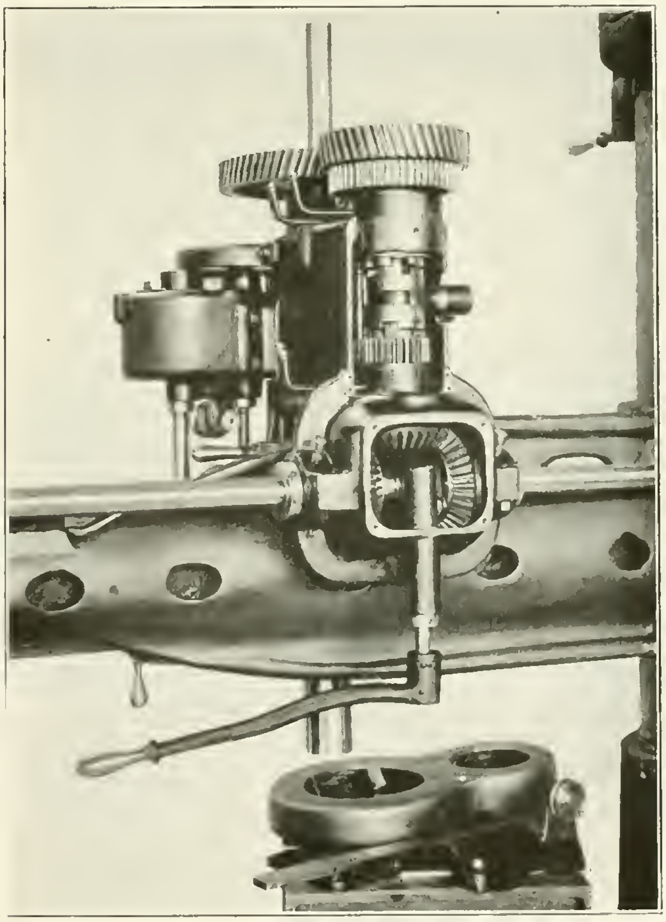


General View of Morris Radial Drill

practice, except that being supported on both a large ball bearing and a roller bearing, the arm can swing with exceptional ease. Suitable arrangements are made to rigidly clamp the column in the stump. The arm sliding on the column has a long bearing and can be clamped in any position by one lever, conveniently located. The arm can be raised and lowered by power through the lever at the top of the column. This lever has a tendency to throw itself into neutral when the tumbler gears are engaged, thus making it necessary for the operator to keep his hand on it when raising or lowering the arm. The tumbler gears are idle except when forced into mesh by the lever. The base, which is exceptionally deep and well ribbed, is provided with the usual T-slots and oil channel. The oil reservoir has an overflow partition to keep chips and dirt out of the pump.

The illustrations show a general view of the drill and a rear view of the head, which is heavily constructed. The head, being carefully balanced on the ways of the arm, travels freely and an extra wide tapered gib is provided to take up the wear. The clamping arrangement consists of two screws operated by one handle against the gib. The angle of the teeth of the helical spindle gears shown is great enough to insure more than one tooth meshing at a time, which avoids end thrust and eliminates the slight chatter usual with spur gears. The use of helical gears also insures a quiet, strong drive. A graduated dial depth gage, which trips the spindle speed at the desired depth, is another valuable feature of this new radial drill.

The back gears, mounted in a fully enclosed bracket, directly in back of the head, are made of 3½ per cent nickel steel, heat treated and hardened. Through these gears two speeds are obtained by a lever on the left hand side of the head. The reversing gears and friction clutches are mounted



Rear View of Head Showing Heavy Construction

in the same bracket, fully enclosed and running in oil. The lever controlling the reversing or tapping attachment is at the lower right hand side of the head, within easy reach of the operator.

The drill spindle is a hammered forging of high carbon steel, ground true to size and the end thrust is taken care of

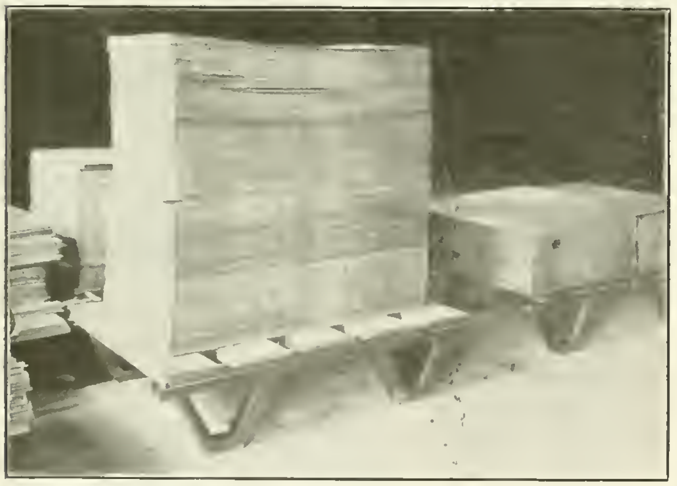
by a ball thrust bearing. Four feeds are obtained and marked on a dial in thousandths advance per revolution of the spindle. The feed can be automatically tripped at any depth within the traverse of the spindle. All the spur gears are hobbed and the bevel gears are carefully generated on a gear shaper.

The speed box is mounted on the base of the machine and six speeds are secured by means of the vertical lever on the front of the box and the friction lever on top. The latter controls the double friction clutch on the pulley shaft and when in neutral position stops every revolving part except the pulley shaft. All friction clutches in the feed box and the tapping attachment are of the expanding ring type. The rings are ground in an expanded position, thus insuring true contact when thrown in. They are of large diameter and wide face and are capable of a pulling power considerably greater than the capacity of the machine. The bearings throughout are made of bronze, arranged with oil chambers, the oil being drawn into the bearings by felt wipers. Arrangement is made for constant speed motor drive with the gear box, or variable speed motor drive through one pair of gears to the lower shaft. In the latter case a four-to-one variable speed motor would be necessary.

This radial drill is made in three sizes, 2½ ft., 3 ft., and 3½ ft. The maximum distance between the spindle and the base is 52⅜ in., and between the spindle and the table is 31⅜ in. The spindle traverse is 12 in., and spindle speeds vary from 20 to 400. A 3-hp. motor is required to drive the machine.

STEEL SUPPORTS FOR ELEVATING TRUCK PLATFORMS

The introduction of elevating trucks, now extensively employed around shops and storehouses, necessitates the use of special types of truck platforms. These have usually been made of wood and considerable trouble has been experienced, especially where heavy loads are handled, owing to the fact that the skid on which the platform is mounted frequently breaks, causing trouble in operation aside from the expense of repairs. To obviate this difficulty, the Lyon Metallic

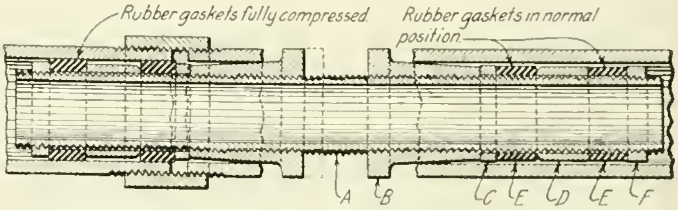


Steel Supported Truck Platform Loaded with Tin Plates to Capacity Greater than the Truck Can Lift to Show the Strength of Construction

Manufacturing Company, Aurora, Ill., has devised a steel skid leg. It consists of two welded feet which are in turn welded to a steel channel, this channel being provided with bolt holes spaced at suitable distances to provide for bolting on either a wooden or steel top. The skid legs can be used for platforms of any width depending on the length of the cross pieces. Another advantage of this device is that additional platforms may be carried in stock, knocked down, so that they take up very little space and yet are available when needed. The illustration shows a platform constructed with these skids, carrying a lead of seven tons. This is a greater weight than could be carried on the elevating truck but shows the great strength obtained with this method of construction.

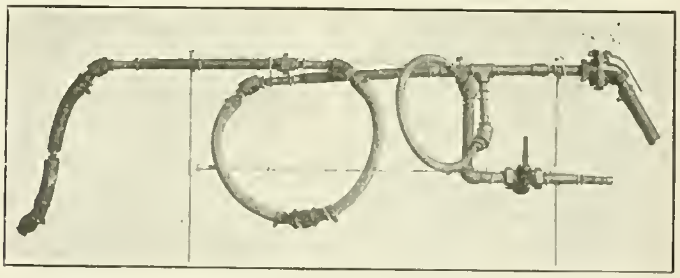
EMERGENCY CONNECTIONS FOR BRAKE PIPES

The attention of railroad men and supply manufacturers is constantly being given to improvement in the installation and repair of train pipes, with the result that many useful devices have been developed. One of these devices which has proved very efficient is shown in the illustrations. It is a method of coupling broken pipes which does away with the necessity of cutting threads that has been devised by J. L. Broschart and is now being manufactured by the Broschart



A Pipe Coupling Which Can Be Applied Without Tools

Threadless Pipe Coupling Company, Trenton, Mo. The object is to facilitate repairs in case of breakage of pipes forming part of the air brake or steam heating system either on locomotives or cars. In actual service as a part of the equipment carried on locomotives and cabooses, the threadless coupling has been found useful in preventing delays and engine failures, eliminating the necessity of switching cars to the rear of the train or cutting them out with the consequent expense of sending a mechanic to make repairs.



Method of Using the Emergency Connection in Making Temporary Repairs to Broken Brake Pipes

As shown in the illustration the coupling consists of a short section of pipe *A*, which carries two jam nuts *B*, and *D*, rubber gaskets *E*, and lock nuts *F*. In case a break occurs in the train line, the ends are separated about four inches enabling the coupling to be inserted in the pipe. By turning the jam nuts, the rubber gaskets are compressed and forced out against the walls of the pipe making an air tight connection. If the break occurs at the end of a pipe coupling or union, the tapered end of the jam nut is sufficiently long to allow the gasket to extend through into the pipe and make a tight joint. By the use of other fittings train lines can be connected even though the broken ends cannot be separated and in a similar manner angle cocks can be replaced and other air or steam pipes can be connected or plugged. The coupling can be applied without the use of any tools. It will withstand the standard trainline pressure and will not interfere with either service or emergency applications of the brakes.

HARTEND GENERAL SERVICE CAR, AND HART DOOR GEAR

There are in service a large number of gondola cars fitted with drop doors through which more or less of the load may be dumped when the cars are handling bulky products such as coal or road building material. To be of the greatest value when handling such commodities, the drop doors should occupy the maximum possible proportion of the floor area in order that the least amount of shoveling may be necessary to clear the car. Such cars have been built with doors occupying the entire length of the floor on both sides of the center sill. In such designs, however, it has been difficult to secure sufficient structural strength at the corners to prevent distortion of the frame from the use of the push pole, so that the doors bind and are not easily operated.

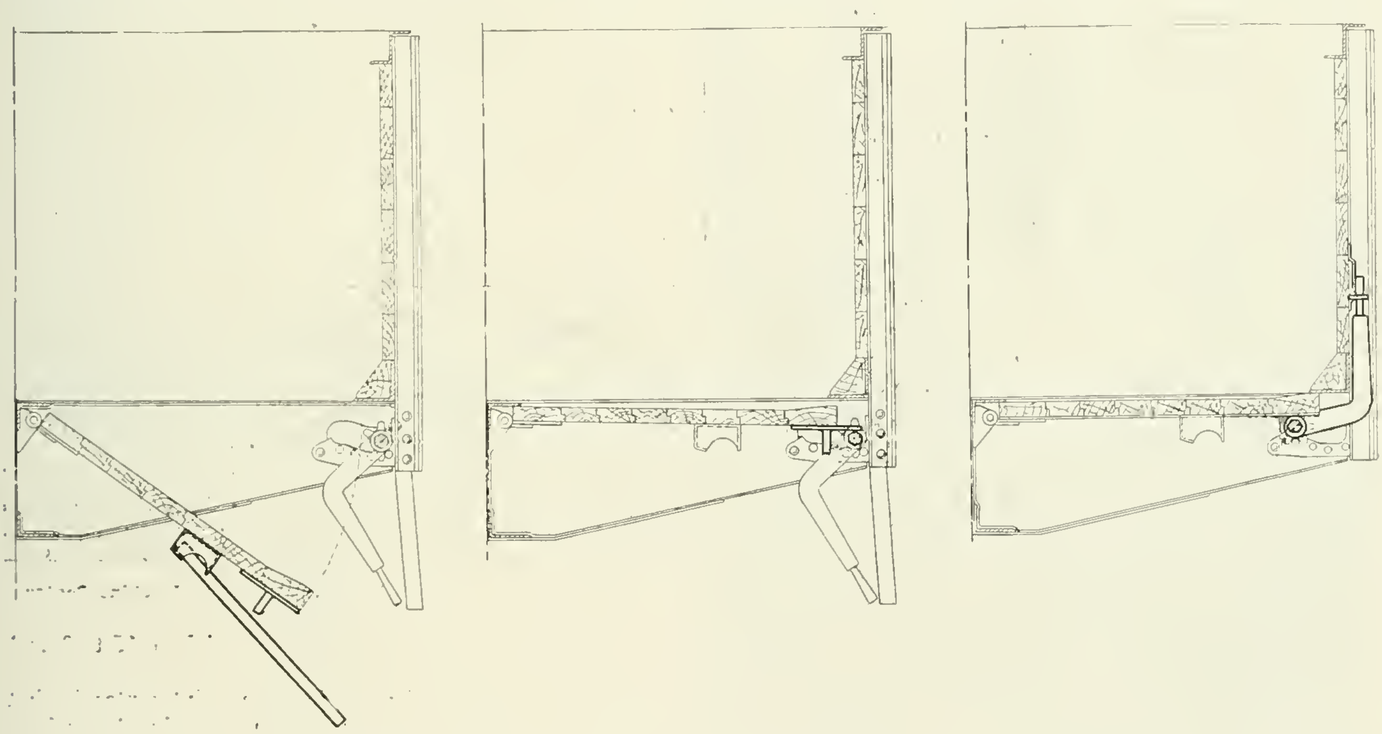
In a number of designs this difficulty has resulted in the exclusion of drop doors and the use of a solid floor between the bolsters and end sills. Another difficulty which has discouraged the use of doors beyond the bolsters is the fact that, with these doors included, the operating mechanism must be placed at the end sill of the car at each corner. Here it is usually unprotected from abuse which frequently renders the mechanism inoperative.

With these two objections to the usual design of completely self-dumping gondola cars in mind, the National Dump Car Company, Chicago, has developed a design of drop bottom gondola known as the Hartend general service car. The purpose of this design is to provide a stiff end construction incorporating a solid floor plate from the end sill to the bolster at each end of the car, but arranged in such a manner that the load in this part of the car may be dumped at the side, as it would be through a drop door. How this has been accomplished is indicated in the illustration showing the end elevation and interior of the car. Between the bolster and end sill at either end the floor plates are sloped downwardly and outwardly from the center sill, in effect forming a hopper at each corner of the car. The outer sides of these hoppers are closed by swinging doors hinged at the top and easily closed and locked by hand. This design provides a rigid end construction, provides for the complete discharge of the load with practically no shoveling, and incidentally provides cubical capacity in the corner hoppers for from one and one-half to two tons additional load. A level floor is retained between the bolsters so that the suitability of the car for loading with lumber, rail, ties or other similar material is unaffected. As the hopper doors are readily operated directly by hand, this design permits the drop door shaft operating mechanism to be placed at the bolster where it is not exposed to damage from corner blows as it is when located at the ends of the car.

Another feature of recent development which is included in the construction of the car illustrated is a simple door looking and dumping mechanism, which may be applied to the drop doors of any general service gondola car of conventional design.

Generally speaking, door operating mechanism is more or less troublesome to maintain in satisfactory operating condition. Where chains are used to raise the doors they usually offer some obstruction to the movement of material in unloading and frequent readjustment is required to insure uniformity in closing all of the doors operated by one shaft. In the Hart door gear no attempt has been made to provide for the closing of the doors by the operating mechanism and all chains or other flexible connections between the doors and the shaft have been eliminated. Each door is closed by hand and temporarily latched, after which each group of doors is permanently locked as a unit. In unloading, a half turn of the permanent locking shaft releases the whole group.

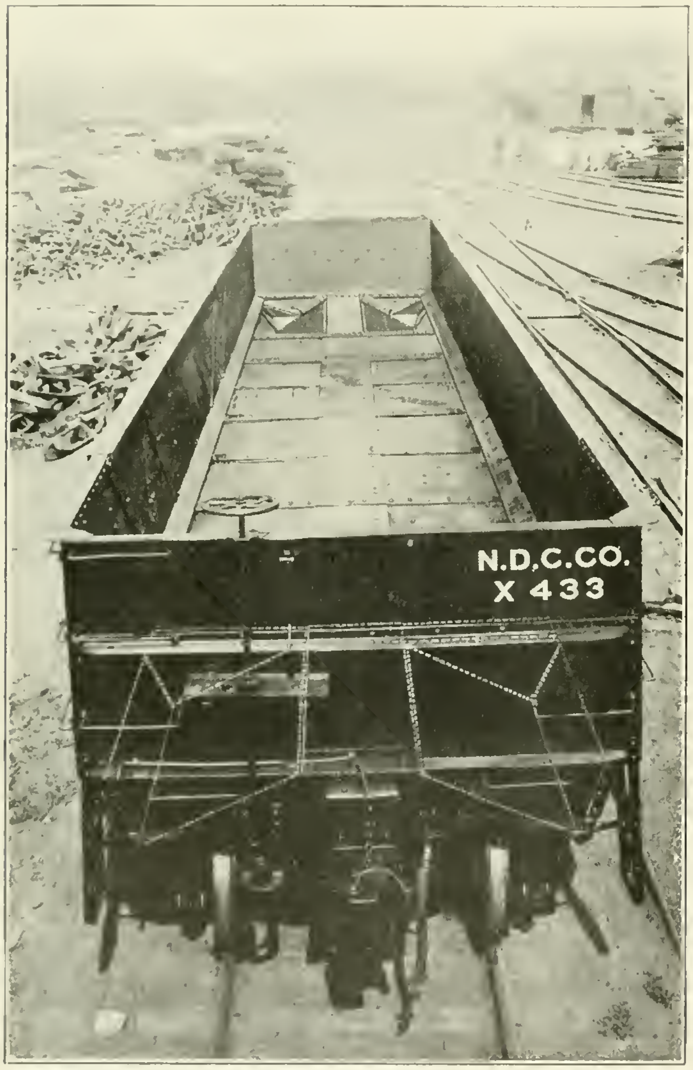
For closing the doors each is provided on its under side with a metal socket and fulcrum so arranged that when the end of a short lifting bar is inserted in the socket the bar is held in a position convenient for raising the door. Mounted in short slots formed near the outer ends of the cross members of the underframe is a rolling shaft. When the doors are opened this shaft is moved to the outer ends of the slots, close to the side of the car so that it clears the outer edges of the doors. With the shaft in this position, as each door is raised by means of the lifting bar, the operator moves out a simple sliding latch on the under side of the door so that



Half Sections of the General Service Car Showing the Operation of the Hart Door Gear

its outer end rests upon the shaft, thus temporarily securing the door in the closed position. When all of the doors in each group have thus been secured they are permanently locked in the closed position by rolling the shaft inward through one-half revolution. For this purpose an operating lever is permanently attached to each shaft. In locking the doors this lever is turned up against the side of the car and locked in position by a sliding link, which is dropped over its end. As the shaft travels inward it engages the downwardly projecting lug or handle on the temporary latch and moves the latch back so that in dumping it offers no obstruction to the dropping of the door.

The drop doors are divided into two groups on each side of the car with the operating lever on each locking shaft located at the bolster end of the shaft. To dump all of the doors in each group the link is raised off the end of the



The Hartend Car Showing the Side Hoppers at the Ends

shaft operating lever, which is then turned outward and downward through approximately one-half revolution, thus rolling the shaft out from under the doors and allowing them to drop by gravity.

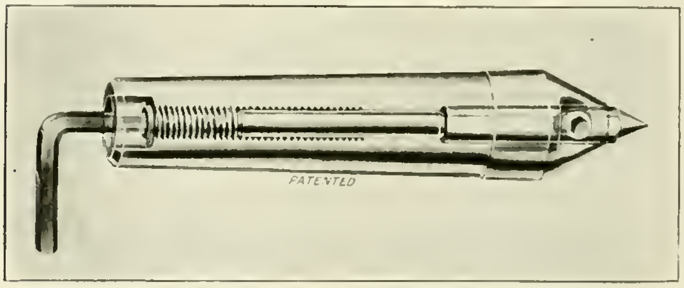
From an inspection of the drawings, it is evident that the rack on which the shaft is rolled is slightly elevated toward its inner end so that locking the shaft also tends to close the doors tightly against the bottom of the car. By closing each door individually any dirt or obstruction which might interfere with its proper closure is cleaned off so that the doors are easily closed and locked without being strained themselves or putting excessive strains on the locking mechanism. Should they be warped or sprung, however, the slope of the rack on which the shaft rolls affords a range of about 1 in., within which a sprung door causes the operator no difficulty in the closing and locking operations.

A sample car incorporating the end hopper and the Hart door operating mechanism has been in service several months handling soft coal. In this service it has proved to be self-clearing and incidentally has demonstrated its advantage in many instances, where cars are being unloaded into wagons on a team track, of making it possible to dump a small portion of the load at one corner to afford a place for shoveling without dumping an entire quarter of the load, as is usually necessary.

ADJUSTABLE POINT CENTER

An adjustable point center for lathes and grinding machines with several important advantages is shown in the accompanying illustration. The inserted point, made of specially hardened high speed steel, is held in place by a locking screw and can be adjusted for wear by means of the central pin and adjusting screw indicated. The body of the device is made of carbon steel with a hardened surface to prevent mutilation and a soft core for greater strength.

It is claimed that the use of this center in either a lathe or grinder will result in considerable saving over the old style of solid center. The high speed steel point will not readily overheat or burn, and when it does require grinding can be removed easily without moving the tailstock. The time required for grinding also is reduced because of the shorter angle to be ground and heavier feeds which can be



Robinson Adjustable Point Lathe and Grinding Machine Center

used. The grinding time has been reduced from 15 to 2 or 3 minutes.

Another advantage of an adjustable point center is that no allowance need be made for wear in the body. Therefore, the work being turned is brought closer to the tailstock and spindle, which reduces the chatter and protects the machine from extra wear. As the point is gradually worn, it is adjusted with the regulating screw, and when finally worn out the point alone may be scrapped instead of the whole lathe center.

This adjustable center is made by the Robinson Adjustable Center Company, Detroit, Mich., and can be used in the spindle or tailstock of any of the standard lathes or grinding machines.

Increased Wages Consumed 97 Per Cent of Increased Rates.—Increases in freight and passenger rates made during federal control amounted to $1,835,000,000 when applied to the traffic moved up to July 31, 1919, while the increases in wages applied to the number of employees and the hours or days worked in July, 1919, amounted to $1,774,800,000, or 97 per cent of the revenue from the increased rates, according to a statement compiled by the Interstate Commerce Commission at the request of Senator E. D. Smith of South Carolina.

ADJUSTABLE WALL RADIAL DRILL

The field for the use of wall column radial drills has been materially extended by a power elevating device incorporated in the radial drill, illustrated in Fig. 1, developed

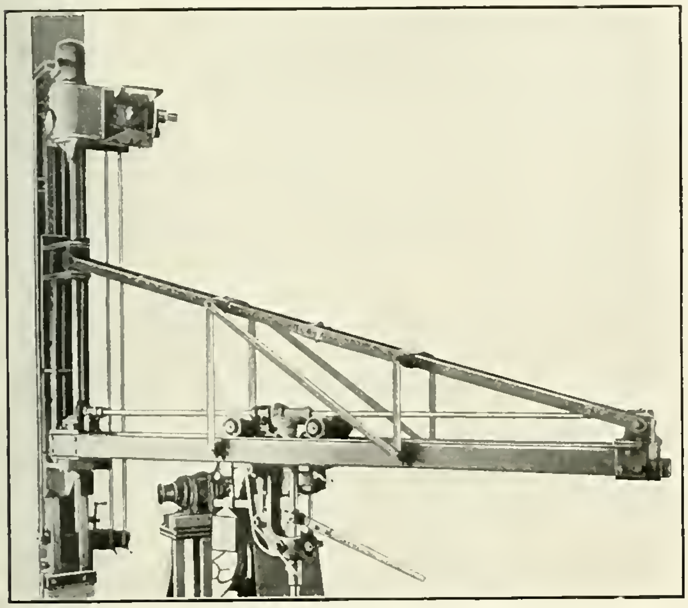


Fig. 1—Lynd-Farquhar Wall Column Radial Drill.

by the Lind-Farquhar Company, Boston, Mass. The power elevating mechanism increases the capacity, and makes the

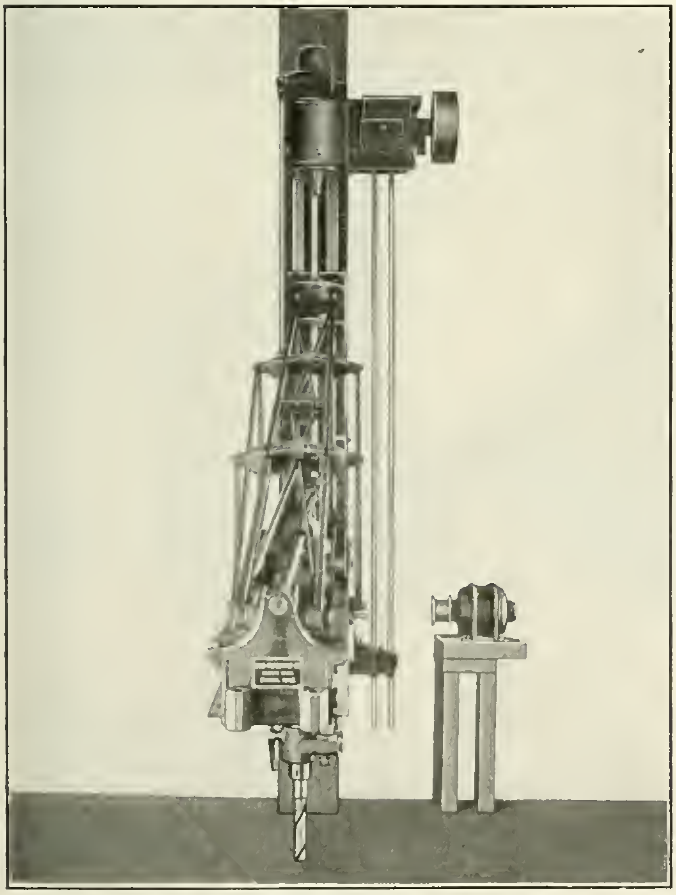


Fig. 2—View Showing Rigidity of Construction.

machine adaptable to a greater range of drilling operations. A four-foot vertical adjustment of the arm on the column is provided for and controlled by means of a vertical controller rod. An interfering device is provided which prevents the operator from raising or lowering the arm at high speeds, eliminating the chance of breakage from this cause. A friction coupling is also provided in the elevating mechanism, which will prevent breakage in case the operator neglects to lower the gib screws on the column.

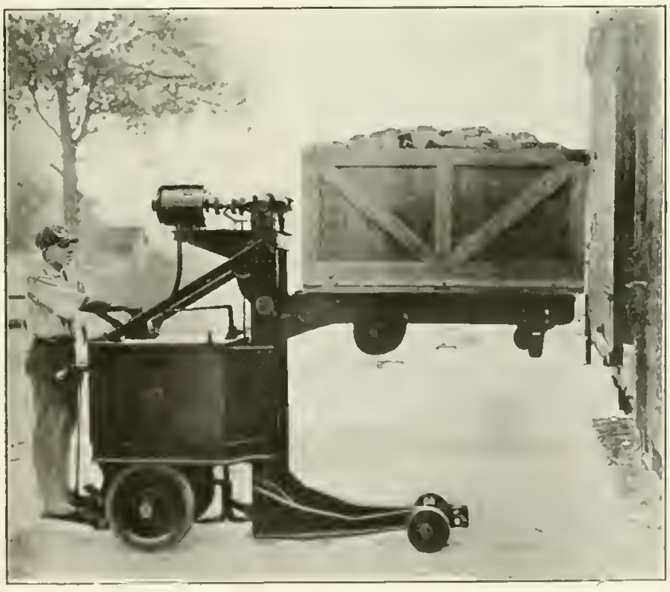
The rigid construction of this wall radial drill is shown in Fig. 2, which also indicates the motor drive and vertical controlling levers. In addition to the vertical braces, 1-in. by 3-in. tie rods are used, and in this way a very rigid and substantial structure is secured.

Four changes of spindle speed are provided through an improved design of gear box with a single pulley drive, which readily lends itself to a compact arrangement for motor driving, with a silent chain and sprocket when desired. These four speeds are controlled by conveniently located levers within easy reach of the operator.

TIER-LIFT ELEVATING TRUCK

An industrial truck, which with its own power elevates the loads to sufficient heights to put the material in box cars or stock rooms without rehandling, has been developed by the Lakewood Engineering Company, Cleveland, Ohio. This new truck performs the functions of a tiering machine as well as those of a load-carrying storage battery truck, and is called the Tier-Lift truck. It can elevate a two-ton load to a maximum height of 76 in., or to any intermediate height.

It has always been customary to transport material by means of hand trucks or some kind of power-driven truck which acted as a carrier only, but with this method men are required to transfer and lift the loads, and even when cranes are available considerable manual labor is required to handle the material. The use of this Tier-Lift truck, however releases the cranes from considerable work, gives a more flexible distribution system and reduces the waste of man-power



Elevating Truck Placing a Load in a Box Car

The height to which material can be piled economically is greatly increased and the storage capacity of a given floor doubled or tripled by the high lifting feature. The storing of material on skids to prevent rehandling in the storeroom is also made practical. Where the material is such that it can bear the weight of loads above, the loaded platforms can be piled on top of each other. The labor cost is thus reduced, material can be handled more quickly and the storage capacity of the floor space is greatly increased. With the

arrangement shown any loaded platform in the racks may be removed without disturbing the other loads, thus giving flexibility in the storeroom.

It is claimed that the four-wheel steer allows the truck to turn in a circle 92 in. in radius, thus permitting operation in narrow aisles or congested parts of the plant, and giving easy entrance into box cars, small storerooms, etc. The same form of drive is used in this truck as in the Lakewood tractor. There are three speeds forward and three speeds reverse. The controller handle is conveniently located for operation for travel in either direction. The lifting mechanism is operated by means of a specially designed controller with one speed in either direction. The lifting is done through two steel worm screws, a separate motor being used to supply the power.

The load platform is carried by a cantilever type support and the load is balanced over the carrying wheels. Ball bearings are used throughout and by a special design the friction losses in elevating and lowering the load platform are greatly reduced. It is claimed that the truck is easy to operate, and its use will result in a considerable saving of both time and labor.

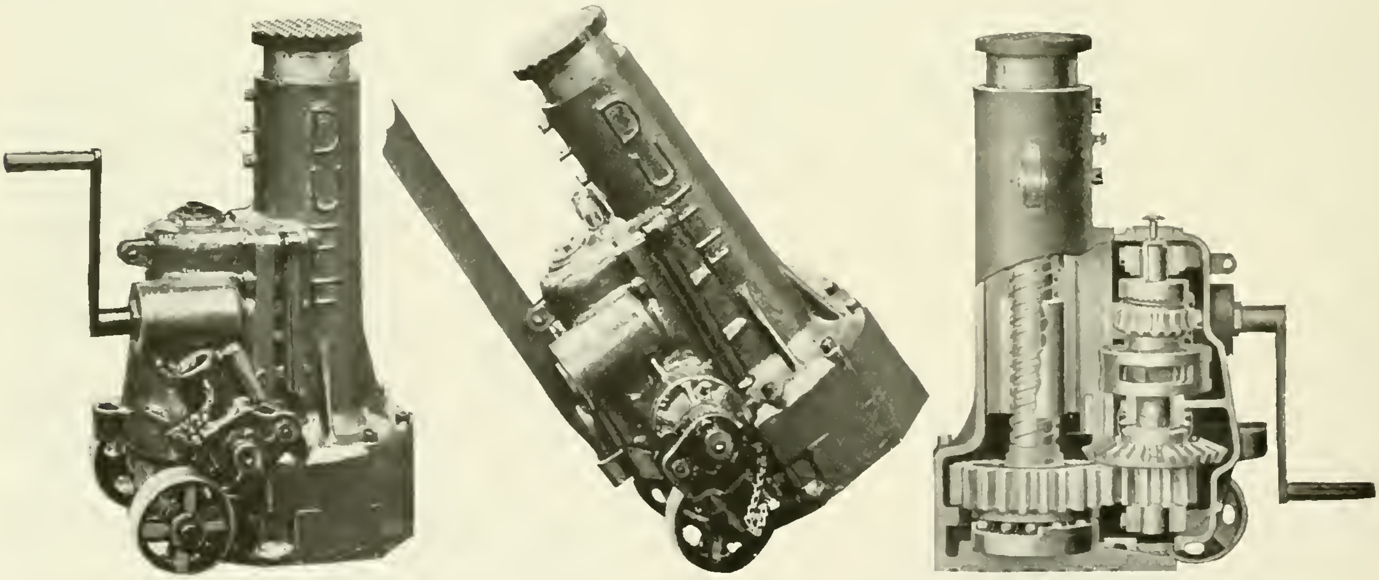
POWERFUL HIGH SPEED JACK

Several new features of construction are embodied in the latest design of high speed ball-bearing screw jack, built by the Duff Manufacturing Company, Pittsburgh, Pa. This 75-ton jack is particularly adapted for handling locomotives and other heavy railway equipment, because it is powerful, quick acting and can be moved easily. The distinguishing feature of this jack is the fact that the operating mechanism, instead of being located in the head, is placed in the base. As shown in the illustration, the weight is thus concentrated at the bottom instead of the top and the jack is not top-heavy. Another advantage is that the point at which the operating lever is pivoted does not rise with the load, which allows a full, powerful stroke regardless of the height of the load.

The Duff jack is unusually easy to move about, not only because the concentration of weight in the base gives a low center of gravity, but because, by inserting the operating lever in a special socket, the jack can be tipped over by one man and rolled on its own wheels wherever needed. The load on the jack is raised by means of a six-foot steel lever which operates a double-thread screw through a ratchet and gearing. The screw has a steep pitch, making the action exceptionally rapid for a jack of this capacity. The screw is made of special machinery steel, heat treated, and turns in a bronze nut of special composition. This combination of bronze and hard steel materially reduces friction.

Safety is assured by a positive clutch which holds the load at all times, preventing any possibility of its sinking or lowering. Another safety feature is the signal which is provided to indicate when the jack has reached its maximum height. For lowering the jack a crank handle is used and a few turns only are required, as the action is very rapid. Regardless of the speed with which the load may be descending, it may be safely checked at any point desired. The action is positive, so there is no possibility of the jack sticking during the lowering operation.

For the purpose of testing a Duff jack the rear end of an N-1-s type locomotive, weighing 215 tons, was raised, so that the rear wheels were off the track. It was estimated that the jack supported a weight of over 95 tons, showing that the 75-ton rating is conservative. This new type of high-speed ball-bearing screw jack is made in heights of 20, 24 and 26 in., capable of maximum lifts of 6, 10 and 12 in., respectively.



Duff 75-ton Jack Is Easy to Move and Rapid in Action.

Heating Rivets Electrically.—In a paper read before the American Electro-Chemical Society, Chicago, G. M. Clark states that two American concerns have developed methods of heating rivets electrically. The American Car and Foundry Company employs a method whereby the rivet itself forms a short-circuit connection across the secondary of a transformer. A spring device holds the rivet in the desired position across the ends of the transformer while the operator holds the rivet with a pair of tongs and brings the spring holding device into operation by means of a foot lever. The consumption of electrical energy is about 20 units per 100 lb. of rivets, and the time taken to heat the rivet naturally varies with the size of the rivet. In another type of heater, employed by the Electric Furnace Company, a granulated carbon block forms the short-circuiting device across the transformed secondary, and in turn radiates heat to the rivets. The consumption of electrical energy for this type is about 18 units per 100 lb. of rivets.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 12,200 copies were printed; that of these 12,200 copies 11,064 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 216 were mailed to advertisers, 32 were mailed to employees and correspondents, and 868 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 12,200, an average of 12,200 copies a month.

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The Chicago, Milwaukee & St. Paul, aiming to reduce materially the losses on perishable foodstuffs, has created a new department, heated refrigerator service, in charge of O. M. Stevens. A new design of charcoal heater has been installed in 1,000 refrigerator cars in which are carried food products subject to injury by freezing.

It is reported that the Prussian Railway system is contemplating the use of internal combustion locomotives of the Deisel type to be used on proposed electrified lines, and it has already been decided that such locomotives will be built for experiment having a horsepower of 3,000. One of the purposes attributed to this work that in case of war these locomotives could be used over any tracks, even though electric power was not available.

A statement showing the number of women employed on railroads under federal control, received by the director general from the manager of the Woman's Service Section, shows that between April 1, 1919, and July 1, 1919, there was a decrease of 23.6 per cent in the number of women employed in roundhouse work, a decrease of 18.5 per cent in the number employed in shop work and a decrease of 15.1 per cent in the number employed in the car department.

The Philadelphia & Reading has received orders to turn over 14 of the 17 locomotives that had been built for the Russian government and which were stored at the roundhouse in Reading, to the Cumberland Valley Railroad. Thirty of these locomotives were originally received by the Philadelphia & Reading and were used on different parts of the system, but later a number were sent to the Reading shops, where they were stored after receiving a general overhauling.

Engineering Council has requested and the Director of the Census has ordered that the new census shall include a more detailed classification of engineers, so that technical engineers will be listed separately from non-technical engineers (stationary engineers, locomotive enginemen, etc.), enabling any one to ascertain readily the number of technical men in the United States and in each state. Technical engineers will be further subdivided between civil, mechanical, electrical and mining.

There is an unconfirmed report in Peking, China, that the Ministry of Communications has engaged the services of four foreign experts to assist in the standardization of rolling stock. France, England, Japan and America are said to be represented upon this group. For two years or more a Railway Technics Commission, composed of Chinese, has been working upon this subject. It is reported that this commission will submit to a convention of the mechanical officers of the lines, to be called next spring, a set of standards for goods wagons.

The Southern Pacific (Lines North of Ashland) has been awarded a banner by R. H. Aishton, regional director of the Northwestern region, for obtaining the best results of those roads employing over 2,000 men in the Northwestern region during the recent National Railroad Accident Prevention Drive. Although employing 4,676 men and operating 1,222 miles of road, the Southern Pacific (Lines North of Ashland) had no reportable casualties to employees during the entire period of the drive, while during the same two weeks of 1918 one employee was killed and 13 were injured.

The railway brotherhoods and other labor organizations, having received no encouragement from the Railroad Administration on their latest requests for increased wages, are working on a plan for reducing the cost of living through their own efforts by co-operative buying, production and distribution. Announcement has been made in Washington of the formation of the All-American Farmer-Labor Co-operative Commission, of which the officers of the railway unions are the officers to carry out the plan, and B. M. Jewell has issued a statement indicating the conclusion that increases in wages will not solve the problem, because they result in a vicious circle of increasing prices. The plans are to be perfected at another conference in Chicago, February 12.

The Engineering Experiment Station, Urbana, Ill., will have eight vacancies to fill in the Research Graduate Assistantships at the close of the current academic year. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. An appointment is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the

degree of Master of Science will be conferred. Not more than half of the time of a research garduate assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

The Tank Car Maintenance Problem

An article entitled The Tank Car Maintenance Problem, by Paul Bateman, appeared on page 647 of the November issue of the *Railway Mechanical Engineer*. This was an abstract of a paper presented before the Mid-Continent Section of the American Society of Mechanical Engineers and should have been credited to Mechanical Engineering.

American Firms Offer to Establish Belgian Car Works

According to a despatch from Brussels, copyright by the Chicago Tribune, the Belgian government has asked for offers for the building of railway rolling stock.

One offer has come from two American concerns, the despatch says, the Middletown Car Company and the American Car & Foundry Company, which combined efforts for the occasion. They offer to create on Belgian soil works for the construction of railway cars which would be installed on American lines. They would, however, employ exclusively Belgian labor; only the chiefs and engineers would be Americans.

After the delivery of the ordered carriages this model factory would be put, free of charge, at the disposal of the Belgian State. It would constitute ideal repair workshops with a staff of 2,500 men, which would have gone through a five months' "American training." The works would be connected by about eight miles of railroad.

The Middletown Car Company started in 1917 a model factory for the American army in France at La Rochelle which has an output capacity of 110 railway carriages a day. The parts for the cars would come from the United States and would be put together in the continental shops.

Commenting on the above despatch in New York, W. H. Woodin, president of the American Car & Foundry Company, said that such a plan had been considered while he was in Belgium recently, but the final action had not been taken.

Railroad Labor Leaders Object to Return of Roads and Anti-Strike Legislation

Officers of the 14 principal railroad labor organizations, including the four train service brotherhoods, at a conference with Samuel Gompers of the American Federation of Labor at Washington on December 29, adopted a declaration of principles expressing their dissatisfaction with the President's action in relinquishing control of the railroads as of March 1 and also their opposition to the anti-strike provisions of the Cummins bill, but saying nothing regarding the wage demands which most of them have pending before the Railroad Administration but which have been held in abeyreturned, but the labor leaders recently have been expressing greater concern over the proposed anti-strike law, which would take away much of their power to force wage increases by threatening to strike. The declaration adopted at the conference with Mr. Gompers says:

"That it is the sense of the conference that the control of the railroads should be exercised by the government of the United States for a period of not less than two years, that a proper test may be made as to government control.

"That such test has not been given a fair opportunity during the war times or since.

"This conference is opposed to legislation making strikes of workers unlawful. It is the sense of this conference that penalty clauses in pending legislation on railroads against workers ceasing their employment should be eliminated.

"That the conference favors the enactment of beneficial features of the bills which tend to establish better relations between employees and carriers.

"That the beneficial clauses should be extended to the sleeping car and Pullman Company employees."

MEETINGS AND CONVENTIONS

American Society for Testing Materials.—The annual meeting of this association will be held at the New Monterey hotel, Asbury Park, N. J., beginning on Monday, June 21, 1920. This is a departure from the precedent of long standing of holding the annual meeting at Atlantic City.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 163 Broadway, New York City.

American Railroad Association, Section III.—Mechanical. V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—Arthur G. Henry, Illinois Tool Works, Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Laylor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—H. J. Smith, D. L. & W., Scranton, Pa.

International Railroad Master Blacksmiths' Assoiation.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association. W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 13, 1919	Graphic Production Control	E. T. Spidy	W. A. Booth	131 Charron St., Montreal, Que.
Central	Jan. 9, 1919	Continuation of discussion on November paper, Locomotive Operations, Annual reports and installation of new officers		H. D. Vought	95 Liberty St., New York.
Cincinnati				H. Boutet	101 Carew Building, Cincinnati, O.
New England	Jan. 13, 1919	Steel Specifications	F. A. Weymouth	W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Jan. 15, 1919	Dinner: Addresses by Hon. E. C. Stokes and Hon. Job E. Hedges		H. D. Vought	95 Liberty St., New York.
Pittsburgh	Jan. 22, 1919	Express Transportation	D. N. Gibson	J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Jan. 16, 1919	Idealism in Business	Rev. Z. B. T. Phillips	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Jan. 19, 1919	Preparation of Locomotives at Engine houses and Shops and Its Relation to Fuel Economy	L. R. Pyle	J. M. Byrne	916 West 78th St., Chicago.

PERSONAL MENTION

GENERAL

P. G. Winter has been appointed mechanical valuation engineer of the Chicago, Milwaukee & St. Paul at Chicago, succeeding W. F. Lynaugh, assigned to other duties.

R. G. Bennett, master mechanic of the Pennsylvania at Pittsburgh, Pa., has been appointed superintendent of motive power of the Central division, with headquarters at Williamsport, Pa., succeeding E. W. Smith. Mr. Bennett was born at Brighton, England, on March 31, 1882. He entered the service of the Pennsylvania Railroad in 1900 as a machinist apprentice in the Erie, Pa., shops, completing his apprenticeship at the Renovo, Pa., shops four years later. He graduated from Purdue University in 1908 as a bachelor of science in mechanical engineering and in 1915 he was given the degree of mechanical engineer. While attending college, he worked during the summer months as a machinist, draftsman and inspector and in November, 1908, was appointed motive power inspector of the Monongahela division. He was later transferred to the maintenance of way department and then to the test department at Altoona. In May, 1916, he went to Chambersburg, Pa., as assistant master mechanic of the Cumberland Valley Railroad, but returned to the Pennsylvania Railroad in February, 1917, as assistant engineer of motive power of the Central division and later in that year he was appointed master mechanic at Pittsburgh.

R. G. Bennett

F. S. DeVeny, assistant road foreman of engines of the Baltimore & Ohio, Chicago Terminal, has been promoted to the position of trainmaster at Chicago, succeeding J. W. Dacy, deceased.

Luke J. Gallagher, locomotive engineman on the Northern Pacific, has been promoted to the position of road foreman of engines of the Rocky Mountain division, with headquarters at Missoula, Mont., succeeding H. E. Day, who has been granted leave of absence.

J. A. Marshall, road foreman of engines of the Northern Pacific, at Duluth, Minn., has been appointed acting master mechanic of the Lake Superior division, with the same headquarters, succeeding J. E. Goodman, who has been given a temporary leave of absence.

S. E. Mueller, general foreman in the locomotive department of the Chicago, Rock Island & Pacific, at Cedar Rapids, Iowa, has been promoted to master mechanic of the Dakota division, at Estherville, Iowa, succeeding R. J. McQuade, who has resigned.

F. S. Robbins has been appointed master mechanic of the Pennsylvania at Pittsburgh, Pa., succeeding R. G. Bennett.

G. E. Passage, traveling engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been appointed trainmaster of the Illinois division at Savannah, Ill.

E. O. Smith, master mechanic on the St. Louis & Hannibal, with headquarters at Hannibal, Mo., has been appointed to the newly-created position of master mechanic on the Louisiana & North West, with office at Homer, La.

Clarence E. Trotter, whose appointment as master mechanic of the Lake Erie & Western, with headquarters at Lima, Ohio, was announced in these columns last month, was born on March 29, 1890, at Plainfield, Ind. He was graduated as a mechanical engineer from Purdue University in 1912. He then served a special apprenticeship with the Cleveland, Cincinnati, Chicago & St. Louis and during this time spent eleven months on the Lake Erie & Western investigating the merits of different boiler compounds, with respect to the cost of locomotive maintenance. On completing the apprenticeship course he was sent to the Mexican border as an inspector of material and during the war served overseas as a first lieutenant and a captain in the Forty-second division. In June, 1919, he was appointed assistant enginehouse foreman of the Cleveland, Cincinnati, Chicago & St. Louis, at Brightwood (Indianapolis), Ind., and for a time was acting night enginehouse foreman. He was recently appointed master mechanic of the Lake Erie & Western, the Fort Wayne, Cincinnati & Louisville and the Northern Ohio, as previously noted.

N. P. White, roundhouse foreman of the Northern Pacific at Duluth, Minn., has been promoted to master mechanic of the Minnesota division at Staples, Minn., succeeding William Radke, deceased.

C. H. Wilcken has been appointed traveling engineer and trainmaster of the Denver & Rio Grande, with headquarters at Helper, Utah, succeeding G. W. Bourne, transferred.

SHOP AND ENGINEHOUSE

John B. Davis has been appointed night roundhouse foreman of the Erie at Meadville, Pa., succeeding C. Kinney, transferred.

F. C. Moeller, roundhouse foreman of the Chicago, Rock Island & Pacific, at Blue Island, Ill., has been promoted to general foreman in the locomotive department at Cedar Rapids, Iowa, succeeding S. C. Mueller.

Alden Morgan has been appointed erecting shop foreman of the Erie at Huntington, Ind., succeeding P. F. Myers, resigned.

PURCHASING AND STOREKEEPING

F. E. Johnson, storekeeper of the Baltimore & Ohio at Mt. Clare, Baltimore, Md., has been appointed assistant general storekeeper at Baltimore.

Tom Moore, general storekeeper of the Virginian at Princeton, W. Va., has been appointed purchasing agent, succeeding A. B. Lacy, resigned. D. C. King succeeds Mr. Moore.

T. H. Ryan, local purchasing agent at New Orleans, La., of the Vicksburg & Alabama, has been appointed purchasing agent of that road and of the Louisiana & Mississippi Transfer and the Vicksburg, Shreveport & Pacific.

H. Shoemaker, district storekeeper of the Northwest District of the Baltimore & Ohio, with headquarters at Cleveland, Ohio, has been appointed storekeeper at Mt. Clare, Baltimore, Md., succeeding F. E. Johnson.

OBITUARY

Alfred E. Corbett, locomotive foreman of the Canadian National Railways at St. John, N. B., was accidentally killed while at work on January 16. He was 34 years old and had been in the employ of the Canadian National for about eight years.

SUPPLY TRADE NOTES

The American Car & Foundry Company has begun to purchase approximately $200,000 worth of machine tool equipment.

H. H. Hendricks, formerly connected with the Ryan Car Company, Chicago, has been appointed a salesman for the Camel Company, Chicago.

John W. Fogg, sales representative of the Boss Nut Company, Chicago, with office in that city, has been promoted to railroad sales manager, with the same headquarters.

Irving H. Jones of Chicago, has become associated with the machinery department of Joseph T. Ryerson & Son, and will specialize in sales engineering work for that company.

The Van Dorn Girder Plate Company, manufacturer of railway car appliances, has removed its general offices from 2325 South Paulina street, Chicago, to 608 South Dearborn street.

C. A. Pinyerd, supervisor in the Chicago office of the Safety Car Heating & Lighting Company, New York, has been appointed sales representative, with the same headquarters.

The Cleveland Twist Drill Company has purchased a 17-acre factory site on the eastern outskirts of Cleveland, Ohio, to provide for factory enlargements which it expects to make in the near future.

J. F. Comee, formerly associated with the Camel Company as representative at Chicago, has been appointed manager of sales, with headquarters at Chicago, for the Hutchins Car Roofing Company, Detroit, Mich.

William A. Benson, formerly associated with the Adams & Westlake Company, Chicago, has been appointed assistant manager of sales in the Chicago district for the Hanna Locomotive Stoker Company, Cincinnati, Ohio.

Hal R. Stafford, who has been chief engineer of the Franklin Railway Supply Company, Inc., since this company took over the Economy Devices Corporation, died at his home in Plainfield, N. J., on December 9.

C. R. Ellicott, assistant eastern manager at New York of the Westinghouse Air Brake Company, Pittsburgh, Pa., has been promoted to eastern manager, with headquarters at New York, succeeding Joseph R. Elliott, retired.

E. A. Woodworth, secretary of the Committee on Mechanical Standards of the United States Railroad Administration, has resigned to become special representative for the Chicago Pneumatic Tool Company, with office at Chicago.

E. E. Griest, formerly master mechanic of the Fort Wayne (Ind.) shops of the Pennsylvania Lines West, has been appointed general superintendent of the Chicago Railway Equipment Company, with headquarters at Chicago.

R. B. Jones and E. E. Hart, both formerly of the Dale-Brewster Machinery Company, Inc., Chicago, have resigned and organized the Industrial & Railroad Supply Company, with headquarters at 114 North Desplaines street, Chicago.

Edward D. Kilburn, who since March 16, 1917, has been New York district manager of the Westinghouse Electric & Manufacturing Company, was recently elected vice-president and general manager of the Westinghouse Electric International Company, New York, which was formed in the spring of 1919 to succeed the Westinghouse Electric Export Company.

The American Steam Conveyor Corporation, Chicago, announces that the Atlas Machinery & Supply Company, 1416 Syndicate Trust building, St. Louis, Mo., is now handling the sale of the American steam ash conveyor in the St. Louis territory.

The Schaefer Equipment Company, Pittsburgh, Pa., manufacturers of railway materials, has recently completed arrangements with the International Equipment Company, Ltd., Montreal, Quebec, to handle its manufactures and sales in Canada.

A. P. Van Schaick, special representative at Chicago of the American Chain Company, Inc., Bridgeport, Conn., has been appointed assistant general sales manager of the company, with headquarters at the Grand Central Terminal New York.

The Duntley-Dayton Company, Chicago, manufacturers of pneumatic and electric tools, has changed its name to The Duntley Pneumatic Tool Company. There is no change of officers, the change in corporate title having been for business reasons.

The St. Louis Machine Tool Company is building an addition to its plant at St. Louis, Mo., which will add about 13,000 sq. ft. to the floor space and practically double the capacity for the manufacture of grinding, polishing and tapping machines.

Fred C. Dunham, formerly assistant to the president of the National Railway Appliance Company, has been elected vice-president of the Hutchins Car Roofing Company, Detroit, Mich. Mr. Dunham's headquarters are 103 Park avenue, New York.

Charles Nourse, until recently in charge of the engineering department of the Heald Machine Company, Worcester, Mass., has severed his relations with that company to accept a position with the Lombard Machine Company, Worcester. Victor Bergstrom succeeds him.

The General American Tank Car Company, Chicago, will build a plant on the Mississippi river, a short distance above New Orleans, La., to cost $1,000,000. The new plant will include a machine shop and steel foundry for the manufacture of tank cars, gondolas, flat cars, etc.

The Mid-Continent Equipment & Machinery Company has been organized at St. Louis, Mo., to deal in railway supplies. F. W. Glauser is president, R. H. Wilson vice-president, and J. B. Fidler secretary-treasurer. The offices of the new company will be in the Security building.

The Firth-Sterling Steel Company, McKeesport, Pa., will move its New England headquarters from 35 Oliver street, Boston, Mass., and after February 1 will occupy a new warehouse at 85-91 West First street, South Boston, where complete stocks of Blue Chip high-speed steel and other Firth-Sterling tool and die steels will be carried.

D. L. Eubank has been appointed district manager in charge of the Cincinnati office of the Galena-Signal Oil Company. Mr. Eubank was born November 24, 1869, and was in the employ of the Chesapeake & Ohio from September, 1889, to February, 1911, as locomotive fireman, engineman and road foreman of engines. In February, 1911, Mr. Eubank accepted a position as mechanical expert with the Galena-Signal Oil Company.

Albert Schmid, consulting engineer for the Westinghouse Electric & Manufacturing Company, died in New York on December 31, 1919. Mr. Schmid was closely identified with the early development of electrical machinery in the United States and was also prominent in the electrical world of France, Switzerland, Italy and Great Britain. At the time

of his death he also represented the Westinghouse Lamp Company and had general supervision of its interests abroad.

Frank O. Wells, president of the Greenfield Tap & Die Corporation, and one of the prominent figures in the screw thread industry in the United States, has sold his entire holdings to Frederick H. Payne, vice-president. Mr. Wells retires as president and member of the board of directors, but will remain with the corporation in an advisory capacity. Mr. Payne has been elected president and F. G. Echols, vice-president and general manager, has been elected a director of the corporation.

The Gustin-Bacon Manufacturing Company, Kansas City, Mo., has purchased all machinery and equipment formerly used by the Emery Pneumatic Lubricant Company of St. Louis, Mo., and has also acquired the exclusive rights to the manufacture and sale of the Emery brake cylinder lubricant. E. A. Emery, the originator of the Emery brake cylinder lubricant formula, has become associated with the Gustin-Bacon Manufacturing Company and has direct charge of the manufacture of this product.

Owing to the rapidly increasing use of the American staybolt and the reduced body staybolts by the railroads and industrials of this country, Benson & Co., with general offices at 50 Church street, New York, has been organized to promote the sales and service of the American Flexible Bolt Company products. R. W. Benson, general sales manager, is president of the new company. Both companies will maintain engineering service organizations to study locomotive boiler staybolt problems and aid in their solution.

Arthur W. Wheatley, who was elected president of Armstrong Whitworth (of Canada), Ltd., in November of last year, is now in full control and direction of the Longuiel works. The works have, since their inception, been engaged in the manufacture of tool steels, small tools, railway tires, etc., and with the cessation of hostilities the policy and energies of the firm were directed toward the further development of their products, especially of railway material, for which there is a heavy demand. It is proposed also to develop the manufacture of all-steel wheels for rolling stock.

L. R. Custer, formerly development engineer for the Midvale Steel & Ordnance Company, has been elected a vice-president of the Cambria Steel Company. He was born in Altoona in 1873, and graduated from Cornell University in 1902. His first work was as a machinist for the Pennsylvania Railroad. He later was in the employ of the Baldwin Locomotive Works, and then served as a draftsman for the Jones & Laughlin Steel Company, Pittsburgh. He entered the service of the Homestead Steel Company as a construction foreman and in 1914 was made superintendent of the armor plate department. During the early part of the war he developed the ordnance department of that company. Shortly before the close of the war he left the Homestead Company to go with the Midvale Company.

Major J. L. Hays has been appointed electrical engineer of the Stone Franklin Company, with office at 18 East Forty-first street, New York. Major Hays has a wide experience in electrical engineering problems, particularly as regards electric car lighting. He was graduated from Lehigh University in 1909, with the degree of electrical engineer. Upon graduation he joined the electrical department staff of the Baltimore & Ohio and worked successively as mechanic, draftsman, inspector, general foreman and assistant engineer. From the Baltimore & Ohio he went to the Seaboard Air Line as electrical engineer, and when war was declared with Germany he was commissioned as major in the Quartermaster Corps and was the officer in charge of the electrical section of the engineering branch, responsible for electrical construction for the army in the United States.

The business and property of the O. S. Walker Company, Worcester, Mass., manufacturers of grinding machines and magnetic chucks, has been sold by Oakley S. Walker to a group of men prominently connected with the machine tool and supply business, and the reorganization of the company has been completed. The name of the company will remain unchanged and the new officers are: president, W. B. McSimmon, Boston; vice-president, J. H. Drury, Athol; general manager, secretary and treasurer, Clayton O. Smith. The new ownership brings with it increased financial resources, which will make possible future development and increase of the business. The company manufactures grinding machines of various types and magnetic chucks used in holding iron and steel parts while they are being ground or machined.

John C. Barber, founder and president of the Standard Car Truck Company, Chicago, and inventor of over 75 railway truck appliances, died in Los Angeles, Cal., on December 27, 1919. He was the inventor of a device for limited lateral play in railway trucks which has been applied to about 20 per cent of the freight cars of the country. Mr. Barber was born in St. Lawrence county, New York, on December 12, 1844. In September, 1861, he enlisted in a Wisconsin regiment and served throughout the Civil war. In 1865 he began his railway career with the Chicago & North Western in its locomotive and car-building department at Fond du Lac, Wis., filling various positions there for six years. He then became connected with the mechanical department of the Northern Pacific shops at St. Paul, Minn., and in 1873 was appointed superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Sedalia, Mo. From 1883 to 1885 he was superintendent of the Rio Grande division of the Texas & Pacific, with office at Fort Worth, Tex. From the latter date until he resigned to market his inventions, in 1896, he was in charge of the car department of the Northern Pacific at St. Paul, Minn. It was while serving in this latter capacity that he perfected his invention for lateral roller motion trucks. In 1898 he organized the Standard Car Truck Company, and of this organization he retained the presidency until his death.

J. C. Barber

Jenkins Brothers in the near future will increase the manufacturing facilities for the production of Jenkins valves by the establishment of a plant in Bridgeport, Conn. The manufacture of Jenkins disks, sheet packings, pump valves and other mechanical rubber goods will be continued at Elizabeth, N. J. Alterations and additions to the brass valve department of Jenkins Brothers, Ltd., Montreal, the Canadian branch, have recently been completed, and a new iron valve foundry building 80 ft. wide by 192 ft. long is now in course of construction. This plant supplies Canada and foreign countries, while the Bridgeport plant will manufacture valves for use in the United States and insular possessions.

Lieut. Vernon S. Henry who served prior to the war, in an engineering capacity with the Safety Car Heating & Lighting Company, New York, has re-entered the service of

that company and is now connected with the Philadelphia office as sales representative. Lieutenant Henry is a graduate of Stevens Institute of Technology and at the outbreak of the war attended the first training camp at Fort Myer, Va., and received his commission as first lieutenant in August, 1917. He went to France the following November and was in charge of automatic rifles in the A. E. F., remaining there until May, 1918. He then returned to the United States to assist in the production of machine gun tripods, model 1919, and for his development in this work he afterwards received a citation for meritorious and conspicuous service. In 1918 he returned to France and was in charge of the development of machine gun and anti-aircraft material until discharged from the service in February, 1919.

The Locomotive Terminal Equipment Association, Inc., has recently been organized by a group of manufacturers and dealers in equipment for use in locomotive terminals, for the purpose of studying the needs for improvement in locomotive terminals in order to secure quicker handling, repairing and turning of locomotives. In the distribution of such data as is developed from the surveys made or from other sources, a policy of impartiality is to be followed and no special advantage is to accrue to any individual firm or corporation that may be a member of the association. The officers are: President, William R. Toppan, manager railroad department, William Graver Tank Works; vice-president and secretary, Bruce V. Crandall; treasurer, John S. Maurer, secretary and treasurer, National Boiler Washing Company; general counsel, Frank J. Loesch. The board of directors consists of the following seven members: William R. Toppan, Bruce V. Crandall, Spencer Otis, president, National Boiler Washing Company; William Robertson, William Robertson & Co.; Frank W. Miller, president, F. W. Miller Heating Company; Robert A. Ogle, president, Ogle Construction Company, and Norman S. Lawrence, vice-president and assistant sales manager, Whiting Foundry Equipment Company. The association has headquarters at the office of the secretary, room 1824, Lytton building, Chicago.

Dr. M. E. Pennington has joined the staff of the American Balsa Company, Inc., New York, manufacturers of Balsa wood products, including insulation material. She will be in charge of research and development work. Dr. Pennington graduated from the University of Pennsylvania where she specialized in chemistry and received the degree of P.D She had charge of the chemical department of Women's Medical College of Pennsylvania and later of the City Bacteriological Laboratory of the Department of Health and Charities of the City of Philadelphia; she then established her own clinical laboratory, making a specialty of doing scientific research work in connection with medical research work of practicing physicians. Since 1905 she has been employed by the U. S. Department of Agriculture, having entered the service on part time, doing special research work, and later took up the preservation of foods by better handling methods, especially the application of refrigeration to all phases of the distribution of foodstuffs. Dr Pennington gradually gave up her various other interests and has devoted herself entirely to that line of work under the auspices of the Department of Agriculture since 1907, when the Research Laboratory formally was established as an organization of the department. Dr. Pennington is the author of a number of articles which have appeared in the technical press and elsewhere, dealing, with chemistry, bacteriology and botany. Since her connection with the Department of Agriculture a number of articles by Dr. Pennington on the preservation of foodstuffs by low temperatures, the effect of better methods of handling perishables, also on refrigerator cars, have appeared in the *Railway Mechanical Engineer.*

CATALOGUES

Pipe Cutting and Threading Tools.—A new catalogue, No. 12, of Beaver cutting and threading tools for pipe has been published by the Borden Company, Warren, Ohio. It contains list prices and data for complete tools and extra parts and a large number of illustrations.

Portable Welding Outfits.—Three types of trucks for transporting portable oxy-acetylene and oxy-hydrogen welding and cutting equipment manufactured by the Davis-Bournonville Company, Jersey City, N. J., are described and illustrated in an eight-page pamphlet. One of these is a cabinet truck which provides permanent mountings for the regulators and gages within a steel locker, which also affords space for the torches, hose, accessories and supplies. The other two are open trucks, one having large wheels especially fitted for traveling on rough ground and the other having small wheels, designed for use on floors, pavements and level ground.

Casehardening Materials.—Bell & Gossett Company, Chicago, Ill., briefly describe several products manufactured by them for use in casehardening, in a pamphlet entitled Casehardening Materials. These specialties include a carbonizer known as Hi-Carbon Compound; B-G Compound for hardening, serving the same purpose as cyanide without giving off deadly fumes; Enamelite, which when applied to low carbon steel will prevent the steel from absorbing carbon during the casehardening process, producing soft areas where they are desirable; Bath-ite, a compound used for preheating between 1,200 and 1,600 deg. F., making it possible to heat the work to a uniform temperature away from the air in order to eliminate scale and oxidization; and Cleancoat; for scouring the steel heated in lead baths.

Furnaces for Heat Treating.—Catalogue No. 75, containing 80 pages, 8½ in. by 11 in., has been published by the Chicago Flexible Shaft Company, Chicago, and is devoted to the Stewart gas and oil furnaces, which are adapted to a wide range of heat treating operations. These furnaces burn only gas or oil and are built in many designs and sizes to meet a great variety of conditions, the line being divided into oven, crucible and forge types. Several special features of the Stewart furnaces are described, including a U-shaped bottom slab which makes it unnecessary to use muffles and gives to the furnace area the advantage of the transfer of heat through the bottom and sides of the enclosure. The many types of furnaces are separately described and illustrated, specifications and prices being given also, in addition to which the book contains instructions as to the proper methods of hardening steel, carbonizing, cyanide treating, etc.

Celfor Drills.—Putting Mettle Into Metal is the title given by the Clark Equipment Company, Buchanan, Mich., to a booklet describing the making of Celfor drills and precision tools, and telling of various innovations which the company has put into effect for the benefit of employees, which tend to give them a keener interest in their work and promote harmony between employer and employees. The booklet contains numerous illustrations, one colored two-page illustration showing a general view of the plant and grounds which have been made into an attractive park. Other illustrations show a theatre which is operated by the company without profit and is used by the employees for a great variety of activities; a hospital which is conducted by a hospital association formed among employees, and several homes which are typical of a large number built by the company and sold to employees at actual cost.

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Use the Railway Supplymen

There are many varieties of railway supply salesmen. It is quite noticeable, however, that gradually but steadily these men are becoming less and less of the pure salesmanship type, and are more and more taking on the functions of engineering experts and practical service men. Service, not price, is the prime consideration in the eyes of the keen and far-sighted railroad buyer, and the railway supply manufacturer has awakened to a realization of this and is organizing his forces accordingly. It is indeed not out of place here to note that some of the railway supply manufacturers have helped to bring about this condition by being forced to demonstrate their devices thoroughly and then to follow them up closely in service when they were finally adopted.

The personal factor is therefore becoming of less and less importance in negotiating sales; the hard-headed railway officer is looking for real and lasting results—in fact, he must do this in order to overcome the effect of the rising costs and hold his job, as he will make a desperate fight to prevent being separated from the payroll. Many mechanical department officers realize the opportunity of securing valuable information and assistance from the representatives of the manufacturers, who are constantly traveling about the country and keeping in touch with the best practices on the most progressive roads.

For some reason, however, the railway repair shop authorities do not take this same attitude toward the representatives of machine tool and small tool manufacturers. It must frankly be admitted that Mr. Armstrong, in his communication on "Open the Shop Doors," on another page, has hit squarely on the head a weak spot in the average railway repair shop organization. Many of the representatives of the machine tool and small tool manufacturers—most of them in fact—can qualify as experts on machine tool operation and shop practices. They can bring to the attention of the railway shop management good methods and practices which are used in other lines of industry (which may be applied to advantage in railway shops) and which might otherwise never come to the attention of the railway shop authorities.

It may be argued that showing courtesies to these representatives will take valuable time from already overworked officers and foremen. If so it is time to reorganize the staff or make additions to it, for this condition indicates a tendency to get into a rut, and, like the ostrich, bury one's head in the sand. No railroad shop officer or foreman should be so busy that he cannot give time to studying how to improve the work of his shop or department.

Standard Steam Hose Coupling

Some time ago the Railroad Administration adopted as standard one type of hose coupling for steam heat lines. The matter was decided by a committee and its choice certainly is representative of the equipment used on some of the largest roads in this country. Nevertheless, there has been considerable adverse criticism of the coupling adopted and since there is a possibility that the Mechanical Section of the American Railroad Association may take up the adoption of a standard for the association, the matter should not be dismissed until the relative merits of various types are definitely established.

The hose couplings which have been most generally used are of two classes, one having a positive lock and the nipple set at an angle of 30 deg. with the face of the coupler, and the other type without the positive lock and the angle of the nipple 20 deg. The latter type was selected as the administration standard. The principal criticism of this coupling has been that the angle of the nipple is so small that it causes excessive bending of the hose when coupled, thereby setting up unnecessary stresses and often causing failures. Furthermore, it is claimed that the larger angle facilitates coupling and the positive lock increases the life of the gaskets because it keeps them tightly closed.

In favor of the non-positive lock and the 20-deg. angle it is claimed that the locking parts are easier to manipulate

and that the loss due to the hose being torn off when cars are uncoupled without separating the hose is reduced. It is doubtful whether the latter argument has much weight, because in almost every case when the hose is not uncoupled by hand it is torn off before the couplings part. That the angle of 20 degrees is rather small is shown by the fact that it is specified as the minimum in the recommended practices adopted by the Master Car Builders' Association.

The cost of steam hose is a considerable item and it should be well worth while for the railroads to keep careful records of the comparative service life secured with different types of couplings, in order that accurate data may be available in case it is desired to standardize these parts.

Mechanical Department After March 1

The mechanical department has in the past, and particularly in pre-war days, been looked upon as a more or less necessary evil—as an expense and not as an earning factor. In too many cases the heads of the mechanical department have adopted a subservient attitude and have stood for conditions that in the interests of the railroad property as a whole they should have opposed determinedly and have insisted upon being changed or corrected.

What was the result? Railroad executives waked up too late to the realization that proper maintenance and upkeep of equipment and facilities is a really vital factor in railroad operation. Roads which, like the Delaware, Lackawanna & Western, had taken a real pride in keeping their equipment in as nearly 100 per cent condition as possible, had a fairly comfortable time two or three years ago when the great majority of roads were badly up against it because of the low standard of maintenance of their equipment.

Railroad officers—many of them—deeply resented the fact that the head of the mechanical department of the Railroad Administration, an outsider so far as railroad shop practices are concerned, found it necessary to step in and show up some of their inadequate facilities and equipment. There was a real reason for it, however; it would never have been necessary in many instances if the mechanical department officers had had the courage of their convictions, and had carried the issue to the last ditch with their superior officers in pre-war days.

Mechanical department officers have been prone to criticise and blame the executive officers for not giving them the proper support in their efforts to improve the equipment and its maintenance. This is foolish. It simply indicates that the mechanical department head has lacked force or has not assembled data which would clearly demonstrate his contentions. The executive officers cannot be expected to be fully acquainted with the details of the technical departments; they have heavy responsibilities to bear in directing the properties and they rely upon their subordinates to make their needs known in such a way as fully to justify them in granting authority. It is here that mechanical department officers have fallen down.

Conditions during the past three years have forcefully demonstrated the wisdom of keeping the equipment in first-class condition and of providing adequate facilities for its care. It is not going to be so difficult for the mechanical department officer to drive home his point in the future as it has been in the past—but he must present his argument and data in such a way as to make it really effective and then keep persistently at it, in season and out of season. If he fails, the chances are that in the last analysis he is at fault in not presenting his case in the right way.

The roads go back to their owners on March 1. Congress is doing its best to get a satisfactory law enacted. It ought not to be too harshly criticised if the measure falls short of a reasonable degree of perfection. Many different and conflicting elements have been exceedingly active in trying to have their ideas adopted, and the suggestions have ranged from extreme radicalism to standpat conservatism.

Railroad officers must get this, however. Conditions as to regulation, the attitude of the public, labor and almost every other element have changed radically from those existing before the war. Railroad men must realize this, and must fairly and squarely meet the new conditions with an open mind and a determination to make good in a large way. The interests of the public, the employees, the security holders and the management are so intimately interwoven that putting on blinders and attempting to operate in the old rut will spell disaster.

You may have the idea that after March 1 you will be free of certain restraints that may have rankled in your mind. You may reason that you can drastically handle some things which are not quite as you would like to have them. You may think you can go back into the rut of some of your favorite pre-war methods and practices. May we give just a word of warning? The railroad game is going to be a bigger one than ever before. It will require big men to direct it. You may be one of those big men—but if so, you will have to study and know human nature; you will have to use your head and determinedly stand behind your guns in directing your department with a big broadminded and open-minded attitude. You must view your task in the light of a profession and not as a job.

Foundry Aids Repair Shop

Repair work on locomotives has always been delayed more or less both in back shops and roundhouses by the difficulty in getting iron and steel castings when needed. This difficulty is greater now than ever before because of the recent steel and coal strikes. Even in pre-war days, however, the process of getting castings through the usual channels of stores department and purchasing agent was exasperatingly slow from the shop foreman's point of view. Often the storekeeper at a local shop would have to get in touch with all the other storekeepers on the system before an order could be taken, and when it was finally approved and placed with a foundry the deliveries were very unsatisfactory. Every one is familiar with one result of slow material deliveries—namely, the robbing of various parts from one locomotive to complete another, a costly practice which should not be tolerated. Locomotives must not be delayed in the shop, however, and there is a serious temptation for the men responsible for output to rob the desired part from a locomotive due out some time later. Consider, for example, a locomotive that comes to the shop with a cracked front deck casting not mentioned on the work report. If the casting is cracked too badly to be welded and there is none in stock, there will be a serious delay in getting the locomotive back into service, with the attendant loss of revenue.

One way to avoid the above difficulty lies in the establishment of a foundry in conjunction with the repair shop. Experience has shown that where conditions are favorable it is possible to operate not only a grey iron but also a steel foundry to furnish all the smaller castings, such as driving boxes, cylinder heads, front frames and deck castings, needed. Good quality grey iron castings are now being made in railway foundries, and the relatively greater difficulty in making steel castings has been overcome, as shown by the satisfactory results of rigid physical and chemical tests. With suitable foundry facilities no locomotive would be held up for machine parts, since they could be cast in the local foundry in less than 24 hours. The unit cost of the castings thus made would be high, due to their light weight, and the saving effected has proved in an actual case sufficient to pay all carrying charges on the investment involved.

Not only is it possible to make standard castings promptly, but a pattern of any special part can be made quickly and be cast, whereas the old method of ordering from an outside foundry would require several weeks. There is danger of overdoing a good thing in the matter of special castings, and none should be made unless authorized by the master mechanic. A careful check should also be made of standard castings and none delivered to the shopmen without orders signed by their foremen. Taken altogether, the great convenience of having castings when needed, the reduction in the amount of stock carried on hand and the resulting economy, make the foundry a most valuable adjunct to a large railway repair shop.

Selecting the Type of Locomotive

It is essential to the proper development of the railroads—in the eastern section of the United States particularly—that mechanical engineers and operating officers give careful consideration to the type of locomotives which they expect to build in the immediate future. It is quite probable, indeed imperative, that there be built a great amount of motive power in the next several years, and with the traffic becoming more and more dense the problem becomes one not only of adequate volume of motive power, but also of providing this power in the minimum number of units consistent with a mobile organization.

Just as it is necessary to have a tool of adequate capacity in the shop in order to effect economical production, so also is it necessary to have motive power in units of adequate size economically to perform the service required of them. It is an indisputable fact that 120,000 lb. of tractive power may be more economically maintained and operated if contained in only two units each having a tractive effort of 60,000 lb., than would be the case if the same amount of power were distributed in three units of 40,000 lb. each. The saving in fuel and cost of repairs would be large enough to make such a course desirable, but when, in addition to these savings, the savings in wages of engine crews is considered it is obvious that the fewer units in which the power is contained, the lower the cost per pound of tractive effort will be.

This, however, presents a problem involving track conditions and terminal and transfer point requirements. It will require the best engineering brains in the railroad field to determine the most suitable type of locomotive for a specific service and then to design it to meet the conditions under which it will operate. The successful operation of some heavy switching locomotives recently built for use on one of the larger southern railroads is evidence of the great possibilities lying in this direction. Economy and utility demand that this phase of locomotive design be given the most careful attention.

NEW BOOKS

Complete Practical Machinist. By Joshua Rose, M. E. 547 pages, 5 in. by 7¾ in., illustrated, bound in cloth. Published by Henry Carey Baird & Co., Inc., 2 West Forty-fifth street, New York.

This book is the twentieth edition of the work and is greatly enlarged in scope. It treats of practical machine shop methods in the language of the shop man and gives in concise form many explanations, with suitable illustrations, of the uses of the tools of the shop. As in previous editions the book gives practical instructions in the use of metal working tools and tells precisely how the various operations should be performed. In addition to a description of cutting tools and their uses there are several chapters on the use of machine tools and their attachments. The very important subject of cutting speed and feed is treated in a comprehensive manner which should prove to be of great value to the machinist. Other subjects which are presented in a practical form are boring tools for lathe work, boring bars, screw cutting tools, twist drills, taps and dies, tool steel, vise work tools and slotting tools. The turning of eccentrics, drilling in the lathe, fitting connecting rods, milling machines and tools, grindstones and tool grinding, the setting of slide valves and other subjects of interest to the practical machine shop man are discussed in a chapter devoted to each subject. The book should prove a valuable addition to the library of the shop man.

Applied Science for Metal-Workers. By W. H. Dooley, 467 pages, 5¼ in. by 7½ in., illustrated, bound in cloth. Published by the Ronald Press, New York.

This book is similar in character to Applied Scence for Wood-Workers by the same author, and covers in the same way the general principles of science common to all industries. In addition to this it presents in an easily understood form practical applications of the principles underlying the metal workers' trades. It contains not only a presentation of the data necessary to equip the student for the intelligent study of industrial science, but also deals in a practical way with modern foundry practice, the making of wrought iron and steel, machine shop practice, sheet metals, structural steel and other subjects relating to the metal working trades. A series of questions and problems on each subject gives the student a very thorough examination and illustrates in a lucid manner the purpose of the work done as well as the methods used in performing it.

Proceedings of the Traveling Engineers' Association. Edited by W. O. Thompson, secretary. 366 pages, 5¾ in. by 8½ in., illustrated, bound in leather. Published by the association.

This volume contains the proceedings of the twenty-seventh annual convention of the association held at Chicago, Ill., September, 16-19, 1919. The address of the retiring president, H. F. Henson, is given in full. The reports of the secretary and the treasurer for the year ending July 31, 1919, are included and show the affairs of the association to be in properous condition. Committee reports and individual papers on various topics of interest to engineers and railway men in general are given in full with the discussion by the members. Among the subjects considered are: Methods for handling air brakes; adjusting tonnage of slow freight trains; advantages of the application of stokers to modern locomotives; locomotive efficiency and fuel economy; and caring for locomotives at terminals.

This volume also contains the obituaries of those members of the association who passed on during the year. Among these are Dr. Angus Sinclair and Dr. Walter V. Turner. The sketches of the careers of these two justly honored members of the Traveling Engineers' Association, together with an excellent likeness of each, will give this issue of the proceedings of the association an especial value to the members at large, as well as to a host of men in other walks of life.

Metric Standardization Favored.—Out of 58,226 petitions relating to exclusive use of metric weights and measures in the United States, now in the keeping of the Bureau of Standards, Department of Commerce, 57,800 petitions or 99.27 per cent favor this progress and only 426, or less than 1 per cent oppose it. This unqualified endorsement of metric standards for this country is brought out in the analysis just completed at Washington by representatives of the World Trade Club, of petitions sent to President Wilson and America's national legislators by prominent persons and powerful commercial, manufacturing, civic and fraternal organizations of the United States. Some of these petitions represent unanimous resolutions passed at conventions of organizations with thousands of members.—*Domestic Engineering.*

COMMUNICATIONS

OPEN THE SHOP DOORS

New York City.

To the Editor:

Did you ever stop to consider what this old world would be if we had not interchanged ideas in the past? What degree of progress would have ensued if everyone had had to make original discoveries of all that he utilized in his daily task? How much of that which you accomplish is due to knowledge acquired from others, from practices developed by others? Did you ever introspectively contemplate how your life, your occupation, and your success is dependent upon the dissemination of acquired knowledge?

Realizing these truths and the interdependence of mankind and industry, do you fully appreciate and utilize the avenues open to you for acquiring a small portion of the available knowledge and thus bettering your operating conditions. These avenues are: (1) Technical literature; (2) Technical journals; (3) Demonstrators, salesmen and service men; and (4) Personal observation.

Technical Literature. The most powerful agency today is the printed word. Records of past accomplishments can thus be used as stepping stones for better conditions and improved operation. Here are to be found the fundamental principles underlying all activities, as well as specific applications and a wealth of recorded knowledge.

Technical Journals. The technical journal supplies this same need but with a closer relationship to the specific task. Through it you are kept in touch with developments in advance of their availability in book form. Its many eyes and ears serve to keep you in close contact with the progress from which you can select that which can be most advantageously used without the necessity of saving to personally develop it yourself. Its advertising serves to bring to your door the wares of the world which can be used to increase efficiency, decrease costs and through better operation insure the very existence of your industry.

Demonstrators, Salesmen and Service Men. The developed efficiency of the locomotive of today and its parts such as the stoker, improved trucks, safety valves, automatic fire doors, superheaters, brick arches and numerous minor details has been brought about by the continued untiring efforts of the supply men. True the railroad man has done his share, but if it had not been for the supply man, his service and his energy, would the locomotive be what it is today?

While the relations with the so-called railroad supply man have been more or less close, it has not been so with the machine tool salesman and demonstrators. To them the average railroad shop has a closed door. The machine tool and small tool design manufacture and operation has developed much during the period that the railroads have marked time. Open the doors to the demonstrators, salesmen and service men. Don't turn them loose unguided in your shops, but consult them, let them aid you and you will be surprised at the knowledge acquired and the improvement effected through such contact.

Many concerns stand ready without expense to aid you in bettering your operation through demonstrators, but find it impossible to pass your closed doors. Don't, through fear of the exception who misuses the privilege of entering your shop, reject the good to be derived from the many who will amply repay you for the courtesy. Learn whether you are getting the best operation, whether your tools give the best and cheapest results. Don't blindfold your shop eyes by disregarding this service by the machine tool and small tool manufacturer.

Personal Observation. Go yourself to see what the other fellow is doing, but if you can't go send your subordinates. Go with the spirit of desire to learn and acquire, not to see in what you excel the other fellow. Human nature is such that it is easier to commend than to criticize. Observe with the intention of criticizing your own conditions, improving them and availing yourself of that which is done better elsewhere. Constructive criticism is a force; self complacent satisfaction is stagnation. If you would advance you must utilize the forces at your command and those of most value are the qualities of an open receptive mind and an open door. Open the doors of your shop to the agencies which instill competition and progress, and to the knowledge of others and the results will fully repay you.

G. W. Armstrong.

REVERSING BRAKE SHOES A BAD PRACTICE

Chicago, Ill.

To the Editor:

In the December issue of your publication there appeared an article on brake shoe service, under the caption "Watch the Brake Shoes," which treats of a method of getting the most wear from the brake shoe and one that has been in practice for a number of years. You will, perhaps, be interested in my ideas on this subject and I should like to have them considered as a reply to the article mentioned:

The simple fact that there are still so many unevenly worn brake shoes on our cars today and still more evidence of them in our scrap piles would indicate that something is wrong with the practice of reversing worn brake shoes.

The practice itself has many objections. A brake shoe badly worn wedge-shape transmits torsional strain to the brake beam structure for which it was *not* designed. A turned brake shoe with the thick end at the top must have excessive slack in order to prevent its dragging too heavily on the wheel tread when brakes are released, which is very undesirable. With this slack in the brake rigging, the lower part of the shoe, which is thin, stands away from the wheel several inches. When the brakes are applied, the top of the shoe being in contact with the tread of the wheel, acts as a pivot and allows the lower thin end to slap against the wheel, often breaking the shoe. The position of a turned shoe with the thick portion at the top increases the pressure or drag on the wheels creating a still more severe retarding action on the wheels when cars are in motion and brakes released.

In the common method of applying brake beams the suspension is such that the forward end, plus the weight of the levers and rods, forces the top of the brake shoe against the wheel with a pressure of approximately 16 lb. per shoe. The natural result is a shoe worn thin at the top. If there is excessive slack in the rigging the top point of the shoe is worn. If the proper clearance only is provided, the shoe will wear gradually, resulting in the wedge shape so commonly seen.

Reversing brake shoes is not only a bad practice, which is eliminated by the use of a proper brake beam support, but the labor cost is greater than it should be. It is especially desirable to eliminate labor which is expended on bad practice. This class of labor that changes brake shoes is just as likely as not to change brake shoes that have already been changed. Duplicating labor in a bad practice is still worse.

In summing up the matter, isn't it a question of correcting the cause to get the proper effect?

By properly supporting the brake beam, we compensate for the force that is pressing the top of the shoe against the wheel, so that when the cars are in motion and the brakes released the shoes will not drag against the wheel. This will eliminate the unevenly worn brake shoe and do away with the necessity of careful watching and turning of the brake shoe.

C. Haines Williams
Vice-President, Chicago Railway Equipment Company

Locomotive Operation and Fuel Economy*

Quality of Fuel an Important Factor; Organization and Co-operation Effective in Preventing Waste

BY ROBERT COLLETT

Assistant Manager Fuel Conservation Section, Division of Operation

FUEL costs are a means for measuring progress. Good locomotive performance and good fuel performance are synonyms with good railroading, and it takes pretty nearly everybody on the railroad to bring it about. Three things are essential to real results—good fuel, good locomotives and real co-operation.

It is of interest to note the growth of the fuel problem. For the year 1912 the railroad fuel bill in the United States, for moving trains alone, was $224,516,000. In 1918 it was $495,612,000. Adding 12 per cent for fuel used for miscellaneous purposes, gives a total for 1912 of $251,458,000, and for 1918 of $555,085,000, an increase of 121 per cent. For 16 of the principal roads entering St. Louis the fuel bill for the year 1912, estimating 12 per cent of the total fuel as being used for miscellaneous purposes, was $58,451,000; in 1918, $149,602,000, an increase of 155 per cent.

In that period the number of locomotives in service on these 16 roads increased 9.9 per cent. The average tractive power of locomotives increased 7 per cent. The total freight business handled or gross ton miles increased 24 per cent and passenger car miles increased 4.5 per cent. In 1912 the number of superheater engines on these roads was 6 per cent of the total engines in service. In 1918 this had increased to 30 per cent of the total.

The majority of roads did not keep ton mile statistics in 1912, but for a few of the principal roads that did and which may be considered as an average, the unit basis of consumption decreased in the period of 1918 over 1912 in freight service 8½ per cent per thousand gross ton miles, and in passenger service 8 per cent in pounds burned per passenger car mile, this notwithstanding the fact that the quality of the coal had deteriorated and that the very severe winter in 1918 was also a factor. It has been estimated for the year 1917 and for a considerable portion of 1918 the ash content and impurities in railroad fuel used in the United States increased at least 5 per cent. This is equivalent to 8,400,000 tons, or to 210,000 cars of 40 tons capacity loaded with incombustible material. This will serve to emphasize, if such emphasis were necessary, that although a greater efficiency was obtained on a unit basis the need still exists for securing the greatest efficiency from each locomotive in service and from each ton of coal purchased. It shows the greater penalty being paid for engine failures or poor performance, since the annual cost of fuel on the roads referred to increased from $3,200 per locomotive in 1912 to $7,450 in 1918.

The Fuel Situation

Prior to the beginning of the war the fuel question in many parts of the country could scarcely be considered a problem. Coal of the very best quality was so cheap that in some cases on busy coal-producing roads if a car were derailed it was cheaper to turn the contents down the bank than to salvage it. Slack and mill coal sold as low as 40 to 50 cents per ton and was sometimes dumped on the right of way for want of a market. Little wonder, then, that appeals to the enginemen and others for small savings were not always seriously considered. Sixteen million tons a year was the maximum exported, the larger part of went to Canada. We are now told that some eighty million tons annually are required for export and that Europe's reconstruction plan depends to a great extent on our ability to furnish fuel.

A few years ago Pocahontas and Westmoreland coal sold as low as $1.25 per ton at the mines, or around $2.25 at the seaboard; it is now selling as high as $7 per ton at the seaboard for export and for ship bunkers. The ocean-going freight rate is from $25 to $30 per ton, and American coal recently bought by the city of Vienna at the present rate of exchange represents a cost to them of $50 per ton. Even though the present miners' strike had not arisen, all indications are that with an average winter it is likely that the domestic, to say nothing of the foreign, requirements would not be met. The closing down of so-called non-essentials brings much discomfort and loss to the persons thrown out of employment. At the present rate of consumption each day there is from one million to a million and a quarter tons less coal in the United States. This means that the source of supply for railroad use is rapidly changing and that we must adapt ourselves to using the lower grades of fuel in order that the higher priced eastern coal may be available for ship bunkers and for export. Entirely apart, therefore, from a money-saving standpoint, the absolute need of every reasonable effort in the conservation of our fuel supply is apparent.

What Has Been and Is Being Done

Fuel is the second largest item of expense to the railroads. It ranks next to wages, and in the cost of train operation fuel costs not infrequently exceed that of wages. Fuel economy in railroad service has always received considerable attention, and fuel performance records are now compiled on all roads under federal control. The result is reflected in the saving shown on all roads in the nine months' period, January to September, 1919, compared with same period 1918, of $21,863,990 in passenger and freight service, exclusive of company haul. On a basis of pounds used per switch locomotive mile there has not been a corresponding saving, due to the fact that with the reduced number of locomotives there has been a greater amount of work performed by each locomotive; compiled, however, on the volume of business handled or ton mile basis, switch engine saving amounts to $2,716,500, bringing the total saving for the nine months' period to $24,663,000. Very large economies have also been effected in power plants.

Fuel conservation has been ably supported, but while much has been accomplished much more remains to be done. Officers on individual railroads who have made ample study of the situation say that the surface has just been scratched.

Where Waste Occurs

At a meeting of representatives from each railroad in the Eastern region the question as to the causes of the greatest avoidable waste was asked. The substance of these replies were: Quality of fuel, locomotive conditions, delays at terminal and on the line, locomotive management, and the lack of the co-operation of all departments.

Quality of Fuel

Local environment usually decides the grade of fuel the railroad must use, but the most objectionable thing is to be continually changing the grades of fuel or the preparation of it. Coal containing more heat units or requiring different

*From paper presented before the St. Louis Railway Club.

methods of firing or drafting of the locomotive from that ordinarily used, although giving excellent results on one division or railroad, may almost tie up another from steam failures. Buying for price or even chemical analysis on the open market should be avoided, if possible. The locomotive cannot be adjusted or the enginemen become accustomed to the change over night, and it is useless to expect it. Therefore, since the railroad must have its supply of fuel in order to move other business, less coal and fewer cars to handle it will be used if an adequate supply of uniform grade is maintained.

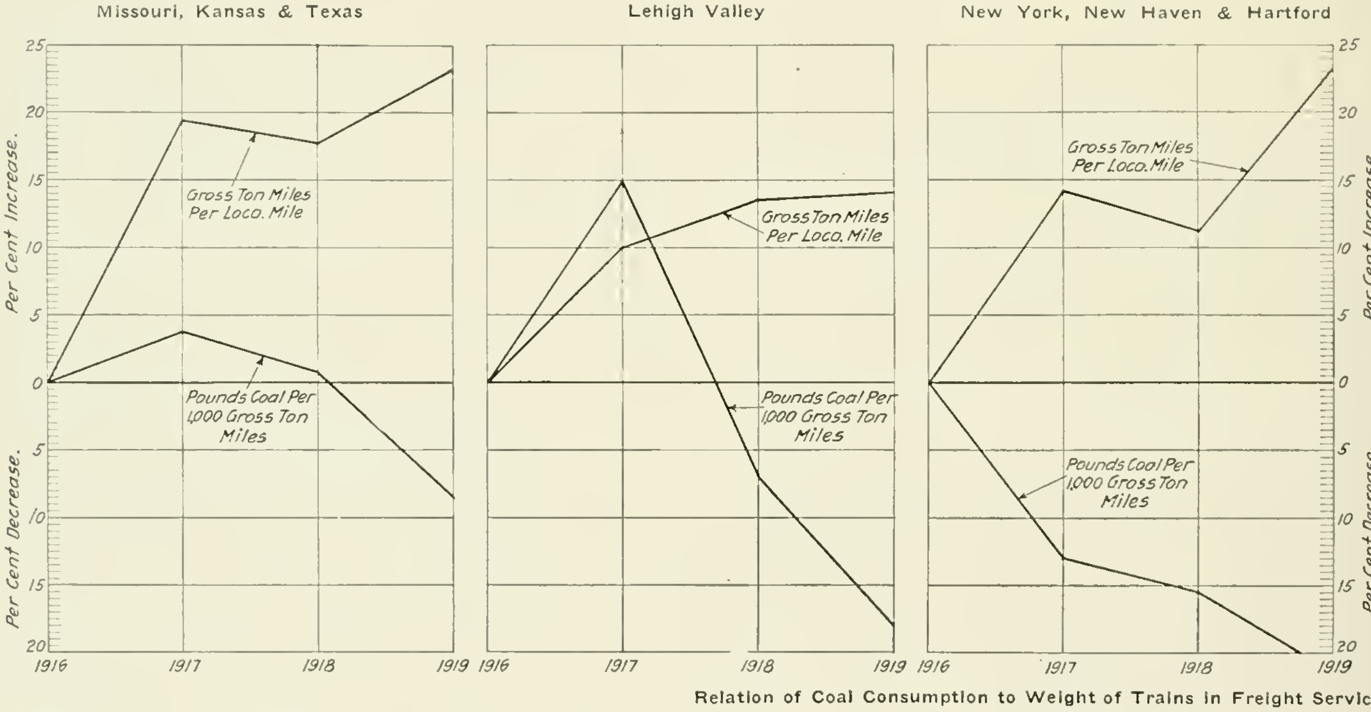
With contracts properly established with mines of known quality, good coal becomes a matter of proper organization and local supervision on the part of the mine operator reinforced by competent fuel inspectors employed by the railroad. A recent check of the number of railroad fuel inspectors indicates that, taken as a whole, for each two thousand dollars worth of fuel purchased less than one dollar is paid for inspection. To justify this expense it would require the coal inspector to effect an economy of only one pound out of each ton of coal purchased, or 1/20 of one per cent. Can we save this much with good coal versus bad coal?

A saving of 5 per cent, or 100 pounds per ton, is considered possible through better inspection alone. We have found coal being rejected by one road accepted by another road and placed on the first road's locomotives at joint terminals. At one point 210 tons per day being loaded for commercial purposes required the services of nine slate pickers to remove impurities; but 900 tons per day from an identical seam were going for railroad use, with no slate pickers on the cars and all the impurities being loaded. Too much emphasis cannot be put on securing the best preparation the mine can produce and on intelligent distribution of the railroad fuel. Where possible, coal should be billed from the mines to the point where it is to be used and so carded that proper grades and sizes will be delivered; otherwise a car of coal is simply a car of coal to the yard men, regardless of kind of coal or equipment. The grade of fuel is the foundation of fuel economy, and mining conditions and miners' contracts have so changed in the past few years that it is just as necessary to build up the fuel inspection and distribution as it was to provide better inspection for pooled than for regularly assigned locomotives.

Recently a few regional fuel inspectors have been put on whose business will be to co-ordinate the ideas and efforts of the present railroad inspection force. In many cases the inspectors for a certain railroad can inspect for another road in the same section that does not maintain inspectors.

Locomotive Conditions

Waste from improper locomotive conditions includes, of course, special appliances which are put on either to save coal or to save work. It is not uncommon to find a modern locomotive with a superheater, power reverse gear and other fuel-saving devices burning from twenty-five to fifty per cent more coal, especially in passenger service, than a saturated engine in first-class condition, and such conditions often exist for long periods without being corrected. If there were some way to know what each locomotive burned each trip and this checked against the amount found by actual test to be required for a given service, it would be startling to know the waste of money that would be shown, and certainly it would not be allowed to go on. Locomotive design, adequate shop and roundhouse facilities are all important and are the foundation for good locomotives. I believe a small amount invested in a running shed at the principal shops where locomotives could be finished, after the "breaking-in" period, by the same shop forces who overhauled them, would be beneficial.



Relation of Coal Consumption to Weight of Trains in Freight Service

A number of roads are getting excellent results from having traveling engineers ride locomotives the first trip from the shop. The defects are taken care of by the same force that overhauled the locomotive, and it is, of course, educational to them—the defects found being discussed in the shop superintendent's staff meeting. Locomotive failure records of roads using the same basis of comparison vary widely, from as low as five and six thousand miles per failure to as high as thirty thousand miles per failure. Aside from correct design, this is chiefly due to lack of attention to details.

We lack education in the care and handling of stokers and other appliances. In the matter of new types of power, European practices are, I believe, better than ours. They get one locomotive and test it out thoroughly, then build the others to that. We buy a large number of locomotives at one time, put them in the heaviest traffic territory, and the man who has to handle them is entirely unfamiliar with the types and, many times, the appliances.

Feed Water

Remarkable results have been accomplished on some roads in the improvement of feed water. On one road having something like 600 locomotives, where flues were formerly changed once in six months, fireboxes removed in from 12 to 18 months, the flues now run the full three-year period and the life of fireboxes increased correspondingly. This has been brought about by intelligent treatment of feed water, although the roads run through, for the most part, a territory which may be considered as bad-water districts from a scale standpoint. Where cost is not prohibitive and better water could be obtained, the source of supply has been changed. Where this was not possible, water treatment has been applied. The organization consists of a chief chemist, with one inspector for about 25 stations, or a total of 5 men for the entire railroad. On this road locomotive failures due to leaking flues were:

Before water treatment	1911—931	flue failures
After water treatment (not complete for all divisions)	1916— 34	flue failures
On the largest division (really two divisions)	1911—468	flue failures
	1916— 1	flue failure

A record of staybolt renewals kept for 1916 showed:

One division without treatment	1916—196	per engine
Another division with treatment	1916— 9.5	per engine

Fire box renewals were as follows:

	Fire boxes applied	Fire boxes per 100 locos.
Before treatment	83	14.1
After treatment	10	1.6

The cost of locomotive failures is difficult to estimate, but it has been stated on good authority that under existing conditions on a busy trunk line railroad $100 per failure may be accepted as conservative.

Many tests have been made showing the fuel loss due to scale, but this represents the expense only partially. Some roads are renewing fireboxes at periods of 10 to 12 months and changing flues even more often.

Heating or lubricating failures waste fuel. Some roads have considerable trouble on this account, although the locomotives are liberally supplied with water pipes. On other roads operating the hardest service and certain trains not making stops over 150 to 180-mile divisions, with not a single locomotive on the railroad equipped with water, heating failures are almost unknown. This has been brought about by specializing at the shops and putting it up to the terminals.

Cylinder and Valve Blows

Some roads run cylinder packing on superheater engines six months or more, and often from shopping to shopping; others make renewals on an average of not more than eight or ten thousand miles.

It has been said that a locomotive new from the builders, having made its mileage and gone through the railroad company shop, should come out a better locomotive than the day it was received from the builders. Whether in pooled service or otherwise, the standard of maintenance of each locomotive should be such as a first-class engineer would have it if running it regularly and being fully supported by the shop forces.

Inspection methods differ widely, but we find that the roads making the best fuel performance give particular attention to this feature and also to the following up of locomotive failures. Inspection must go further than looking after broken frames, wheel flanges and loose nuts.

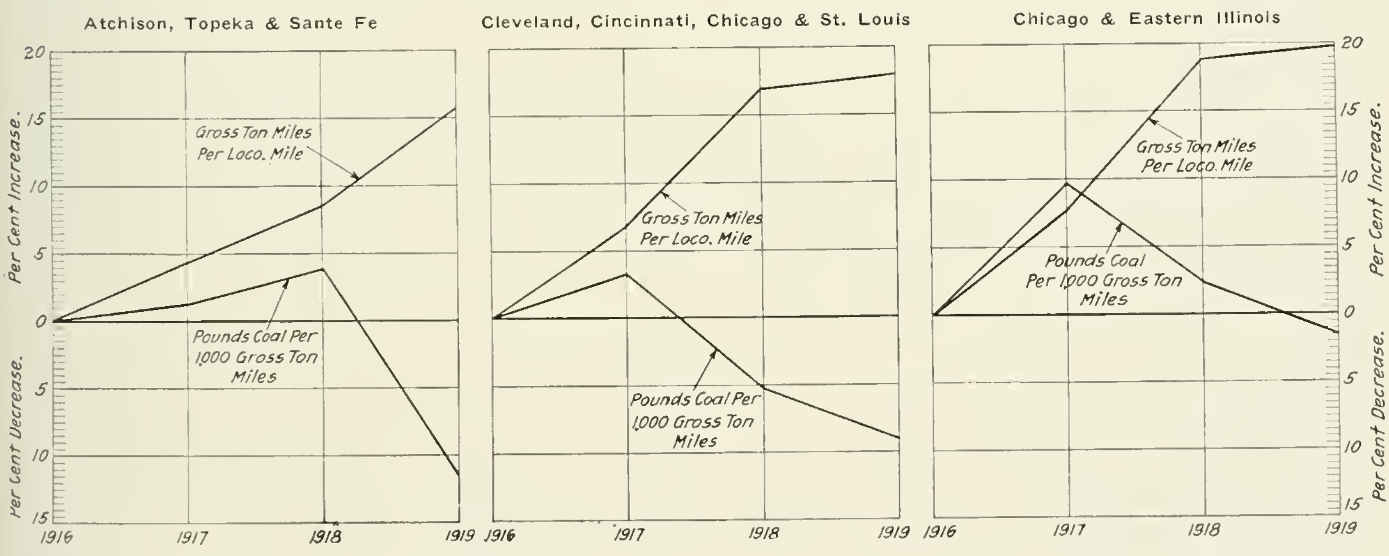
Delays

Certain roads have established standards of rating for movement at terminals and over divisions, for through freight trains, and check up each train daily. As an example, one division on a certain road, comparing with a similar period one year before, increased the train load 16⅔ per cent, decreased the average time of the freight train on the road 32 per cent and decreased the fuel consumption 13.1 per cent. It is claimed that the influence of the chief train dispatcher was the moving spirit in this. Another road decreased the average time of freight trains at terminals 11 minutes each. On both of these roads these standards have been worked out from actual observation.

Hot boxes and equipment failures are responsible for a great waste of fuel and frequently for reducing the average tonnage rating in order that the average sustained speed will overcome such delays. One road has made great progress in this. The average miles per box in service is as follows:

	Total No. hot boxes	Miles run per box
Passenger:		
First nine months—1917	1,615	48,964
—1918	1,072	63,957
—1919	373	147,067
Freight:		
First nine months—1917	29,225	18,434
—1918	26,151	23,479
—1919	12,810	30,033

Their system is such that when a delay occurs or a car must be set out for a hot box they can put their finger, so to speak, on the individual at the terminal responsible for the hot box. But primarily it is due to good shop practice—terminal attention. Good authorities claim that the average cost of a hot box is not less than $10, and when we consider the tonnage lost, wrecks, terminal switching charges, wheel



In the Months of September in Four Successive Years

changing, wages of men sent out, etc., we can readily admit that this is a conservative figure.

The gross revenue for one hundred-mile division for each 70-ton car of coal, the cheapest commodity we haul, is around $45. Not infrequently a train sets out three or four loads over a division because of car equipment trouble or hot boxes. One reason for stressing these points is that the most of the fuel economy bulletins are addressed to engineers and firemen. They are only links in the co-operative chain, and no one knows so well as they do how often their best efforts toward economy are defeated.

Locomotive Management

This, of course, goes back to the early training of firemen and to capable supervision. The use of fuel combustion and instruction cars and of special men with no other duties than that of employing and conducting examinations of firemen is being extended. Under certain conditions firemen are paid during the learning period.

The use of printed forms recording observations of road supervision is now in more general use. Some roads make a summary of such observations each month for the benefit of general officers, in order that they may know how supervisors are directing their efforts, and from these reports also the general condition of the locomotives may be noted. As to methods, there are a number of men on every division of every railroad that know the best way to fire and run each class of engine. Supervision is provided for the purpose of standardizing such methods. In my opinion some such standard form of report is necessary in order that general officers may know that the men who need instruction receive it. By a little study and care, very great reduction in fuel consumption can be and often is made.

A supervisory officer will ride with a crew with a tally counter, counting the number of scoops fired between given points. The fireman will say: "Had I known you were keeping a record I would have done better." We have, as a result of information furnished by supervisors, any number of records where a reduction of from 25 to 30 per cent or even more has been made just through the personal interest of the engine crew in their endeavor to demonstrate just what they could do. Road foremen of engines, fuel supervisors and traveling firemen in the Eastern region, carry a tally counter and hundreds of checks have been made. Many of these records are sent to roads all over the United States with the name of the crew and all of the data of the run.

Poor pumping, failure to regulate the cut-off at high speed, irregular adjustment of the lubricator, shutting superheater engines off at a high speed with valves in short travel, are the most prevalent wasteful practices. We know that these things should not be done, but the men often work under adverse conditions and sometimes are not instructed.

Heavy Firing

A case of heavy firing on a Pacific type locomotive on an 81-mile run with a six-car passenger train was brought to my attention. On the first trip which the traveling engineer rode the engine, 497 scoops of coal were burned, and on the second day, 435. With another fireman on the next trip, 405 scoops were burned, with the same train and an Atlantic type locomotive. A few days later after the fireman had been trying to see just how well he could do, the same locomotive with the same train burned 303 scoops, a reduction of 26 per cent and a reduction of 39 per cent over the Pacific type locomotive. In another case where one of the regional supervisors rode the locomotive—not a case of operation altogether, but largely due to the reverse gear creeping—an Atlantic type locomotive on a 55-mile run, burned 81 scoops of coal. A Pacific type on following day, with the same train and run with two additional slow-downs, burned 230 scoops of coal. While some of this fuel was burned on account of slow-downs, 124 scoops, of coal were burned in the first half of the trip or 50 per cent more for one-half of the trip than the Atlantic type burned for the entire distance. You have but to ask any locomotive fireman with as much as six months experience if it requires more coal for some engineers in the same service than for others, and a similar inquiry to engineers as to whether certain firemen burn more coal than others, will ofttimes bring the reply, "That we might better pay some fellows for staying at home." This seems rather strong, perhaps, but it is facts that we are dealing with and not theory. However, these are exceptions but as before stated, it is for these exceptions that supervision is provided.

Minor Wastes

Large locomotives on light passenger trains waste an enormous amount of coal. A committee of the Air-Brake Association estimated that six million tons of coal annually are wasted by controllable air leaks. Each square foot of steam heat line or other radiation surface uncovered, wastes one ton of fuel per year. If each locomotive on the New York Central Lines popped for ten minutes per trip, it would waste $144 per year and two scoops of coal wasted per trip through decks, at gangways or from overloaded tanks, would mean $54,000 loss, or enough to buy a modern locomotive.

Organization

Many suggestions have been offered as to types of organization. Obviously, the thing to do is to have such plans and purposes as will secure on each road the maximum amount of enthusiastic support from the chief operating officer down. Much of the strength of any organization lies in the general good opinion of those having to live with it. The supervision for locomotive operation and fuel costs has not received the same relative amount of attention as other branches of service. In the transportation department, below the rank of general manager, there are general superintendents, superintendents, trainmasters, etc. The mechanical department is officered likewise, but in locomotive operation we usually find one road foreman of engines on each division reporting to the master mechanic or superintendent. It does the master mechanic or superintendent no injustice to say that in the majority of cases, not having received their training through a similar branch of service and being charged with many other details of operation, the barometer of results being trains on time in one case and engine failures and shop appropriation in another, they are not always fully able to judge as to whether the road foreman or the fuel supervisor is getting full results. There is need for more general supervision. In the first place the road foreman's time may be taken up with a great many other things than the principal that his position is created for. At most there is one man for an average of about 35 locomotives, and since a great deal of his time is not given to locomotive operation, it is fair to assume that the equivalent is more nearly a man for each 50 locomotives. At $35,000 per engine (a conservative estimate) this makes a total of $1,750,000 worth of machinery that he is responsible for between terminals and also for the proper use of $372,000 worth of fuel annually.

There should be one general foreman reporting to the general manager or through the superintendent of motive power or other staff officer. He should have enough assistance to cover the job, whether working through the regular organization or with a special fuel economy staff of his own, but if he handles the work through the road foreman, there should be an adequate number of men—traveling firemen of fuel supervisors—who have nothing but locomotive operation and fuel to claim their attention and whom he can call on. Any man on the railroad, whether he be road foreman or otherwise, who is charged with the supervision of locomotive performance, should assume his full measure of responsibility. If the mechanical department is handling fuel economy, they,

of course, are responsible for calling attention to wastes in any other department and of keeping all the other departments interested.

Co-operation

In giving you these experiences I have tried to show something of the growing importance of the problem. The cost of fuel has increased tremendously and it will probably never be so cheap as now. Some practices, now more or less prevalent, the scope of which might be extended, improving thereby not only the locomotive service, but the railroad machine as a whole are worth mentioning:

First—Better railroad fuel through better inspection and closer co-operation between the mine operators and the railroads.

Second—Improved locomotive conditions by closer inspection, distribution and maintenance.

Third—Improved road and terminal movement by establishing standards of performance and following up of delays.

Fourth—More scientific locomotive operation through better educational methods, supervision and records.

The charts that accompany this paper will serve to illustrate the direct relation that the average gross tons per locomotive mile bears to the unit fuel consumption. A good fuel performance means successful train operation and the maximum per cent of potential tonnage movement. These charts show the close relation between the weight of the train and the pounds of fuel used to earn one dollar.

Discussion

H. C. Woodbridge (Supr. Fuel Conservation Section): I rode on a locomotive recently that had a power reverse gear on it that would stay put. One notch made a difference in the action, and it would stay where you put it. You must make a drive on the transportation department men; you must not stop with the trainmaster and the despatcher, although, the despatcher can save more fuel than several first-class firemen. One of the big railroads has ore trains running out of the Lake Erie ports; one of their heavy trains has a record of having stopped 22 times in 125 miles. That was an old record, and they decided that at least 12 of those 22 stops were unnecessary—and they have been eliminated. But do not stop with the despatcher and the trainmen, or the superintendent, but go to the men at the top.

W. L. Robinson (Division M. M.: B. & O., Washington, D. C.): What has appealed to me most in Mr. Collett's paper was a matter that was passed over rather hurriedly, but it is something that I have made a considerable study of, and that is the matter of measuring the actual amount of coal that is used on the individual locomotive. I think that is the greatest opportunity for fuel saving that we have left.

J. W. Hardy (Fuel Supervisor of the Southwestern Regional District): I do not believe there was ever a time in the history of our country when it was as necessary to have the right kind of supervision as it is now. When men had regular engines, and used to come in and report their work, they gave their locomotives supervision that they do not get today. Their engines are now delivered far from the shop and the work report is sent in by someone else, so that there is not the personal contact that there used to be when the enginemen were personally acquainted with the men who did the work. That, in turn, calls for closer shop supervision. The shopmen do not do their work with the same interest that they did, even in pre-war times. Shorter hours contribute something to that; one man tears a job down, and another one finishes it; in fact, there are many things that require closer supervision. It has only been a few years that we have had locomotive inspectors; that work used to be done by the regular locomotive engineer, and was done much better than it is done by the ordinary locomotive inspector, because the engineer is more interested in the result that he would obtain on the road than the man who just simply inspects the engine. The growing demand for better supervision cannot be emphasized too much.

We need better supervision of our stationary steam plants. While it is true that only about 12 per cent of the total fuel used is burned in the stationary plants, there is a great deal of it used very wastefully. The consumption of fuel always increases in the winter time, and when that increase takes place there is a corresponding increase in waste, so that it is very important for us to turn our attention to all the little leaks.

In addition to the coal used by American railroads, 5,000,000 barrels of oil are used annually. Oil is being used in greater quantities daily, especially in the Southwest, and this trouble with the coal miners is undoubtedly going to make additional demands upon the production of oil. So I just want to mention that there is waste in oil, just the same as there is in coal. Sometimes in locomotive operation, the loss is greater on oil than it is on coal

I just made a trip over some of the oil burning lines in the Southwestern region; there are several things that I learned—small things—but they contribute a good deal to the waste of oil. The matter of the quality of sand used has a great deal to do with the results that you get, and the way it is used has a great deal to do with it. I mention this because I know some of you gentlemen in this meeting are interested in the oil question. Yesterday I received from the Texas Pacific one of the most complete instruction books on the use of oil in locomotives that ever came out in this country. It contains the combined oil knowledge and experience of men in the Southwest and in California who have been using oil in locomotives for several years, and it is gotten out in the form of an instruction book by the Texas Pacific.

E. Hartenstein (Genl. R. F. of E., C. & A.): We have six men in the road foreman's department, and we have made it our business in the last six or eight months to station ourselves at the terminals when locomotives are set out for service to give them a thorough inspection. If we find that any defect exists that would cause an excessive use of fuel the locomotives are sent back and are not permitted to go.

We do not do that very often before the roundhouse foreman aims to see that the locomotives are put out in better condition.

We assume the same authority with regard to continuing an engine in service that is exercised by the federal inspectors; if we do not exercise that authority, we have to explain why to the man above us.

Eugene McAuliffe: A survey of the actual results obtained during the first nine months of this year, and projecting the curve through to the end of the twelve months, shows that after making an arbitrary allowance of seventy-five cents per ton to cover the cost of haul on user's rails, that the reduction in the cost of fueling locomotives and stationary plants including miscellaneous railroad fuel consumption for this year, as compared with last year, calculated on the basis of pounds of coal per unit of service will exceed $45,000,000. The expense of operating the Fuel Conservation Section is only a trifle over $100,000 per year.

The fuel problem is a bigger one than the fuel bill to the railroad. The coal mines of this country today furnish you 38 per cent of your freight traffic—your freight tonnage. They give, in addition, a very material collateral tonnage, in the shape of in-bound machinery, timber, steel, rails, merchandise, and perhaps a measure of passenger traffic that is not small. The mining industry as a whole, both fuel and metal, furnishes the railroads of the United States 68 per cent of their freight traffic. So, from a revenue earning standpoint, there is room for a direct and compelling partnership between the railroad industry and the mining industry.

The job has grown beyond the locomotive engineers and

ex-locomotive engineers. It is a job now, just as it has been for some years past, but to a greater extent now, that belongs to the highest executive officers of the railroads. It is too big to be treated as a secondary proposition. The railroads today are paying an average of $4.05 per ton for coal, excluding the item of haul on user's rails, which I estimate will not be less than 75 cents per ton. I predict that a further increase of perhaps one dollar per ton will be added to the existing mine price. That will add $100,000,000 or $150,000,000 more to the railroad's fuel bill annually—a further incentive to our railroad executives toward taking hold of this problem.

The railroads of this country do not yet know how to buy coal; they do not yet know how to inspect coal or how to receive coal; and while the proposition of how to use it is a tremendously compelling one, reforms in purchasing and inspection methods will, if made, prove of great value.

There is a direct relation between fuel economy and the average weight of train, and if you secure the highest possible advantage through fuel economy the weight of the train will take care of itself. The savings effected not only will be those which flow from the decreased volume of coal consumed, but will be perhaps exceeded along other lines, through the heavier weight of trains, and a general reduction in operating costs.

RAILROAD ADMINISTRATION NEWS

In General Order No. 65, dated December 10, Director General Hines says:

"Grievances affecting employees belonging to classes which are or will be included in national agreements, which have been, or may be, made between the United States Railroad Administration and employees' organizations will be handled as follows:

"(a) Grievances on railroads not having agreements with employees, which grievances occurred prior to the effective date of any national agreement, will be handled by railroad officials in the usual manner with the committees and officials of the organizations affected for final reference to the Director of Labor, as provided in Circular No. 3 of the Division of Labor. Grievances on railroads having agreements with employees, which grievance occurred prior to the effective date of any national agreement, will be handled by railroad officials in the usual manner with the committees and officials of the organizations with which the agreement was made, for final reference to railroad boards of adjustment, as provided in general orders creating such boards. Decisions made as the result of such reference will apply to the period antedating the effective date of such national agreement, and, from the effective date of that agreement, will be subject to any changes that are brought about by national agreement.

"(b) Grievances which occurred on the effective date of any national agreement, and subsequent thereto, will be handled by the committee of the organizations signatory to such national agreement for final reference to the appropriate railroad board of adjustment, except on roads where other organizations of employees have an agreement with the management for the same class of employees, in which case grievances will be handled under that agreement by the committees of the organization which holds the agreement for final reference to the Director of Labor, as provided in Circular No. 3 of the Division of Labor."

Foremen in Mechanical Department Classed as Officers

Because of the exceptional importance of the work of supervisory foremen in the mechanical departments, and the fact that economical and efficient shop operation depends so largely upon their efforts and co-operation, W. T. Tyler, director of the Division of Operation, has issued a circular letter to the regional directors stating that it is desired that their classification, working conditions and privileges be made definite and uniform.

To that end the director general directs that general foremen, roundhouse foremen, departmental foremen and assistants will be classified as officers and will be given consideration and advantages attaching to officers of similar rank in other departments, as follows:

(a) Reasonable period of time lost on account of sickness without loss of pay.

(b) Two days off each month for all salaried foremen whose tour of duty consists of seven days per week.

(c) Two weeks' vacation a year with pay for all salaried foremen who have acted as officials continuously for one year or more.

(d) Privilege of resigning instead of being shown as discharged or dismissed.

(e) When charged with an offense likely to result in dismissal, a hearing to be given by a superior officer other than the immediate superior, at which hearing the foreman in question may be represented or assisted by any other foreman whom he may select for that purpose.

(f) Card transportation to be granted to all salaried foremen, the extent of such transportation to be based on the general practice for other division officers and the importance of the position the foreman occupies.

The letter says: "It is not possible to lay down a definite seniority rule, because ability and merit are of paramount importance in this highly responsible work and, in any event, must govern, but where the ability and merit of two men are equal, the choice of positions on a division should, as far as practicable, be determined upon the basis of seniority. I am sure that the uniformity brought about by the above rules will result in more loyal and efficient service by the foremen affected and will reduce complaints to a minimum. Will you please take action to have this put in effect at once?"

ORDERS OF REGIONAL DIRECTORS

Incomplete Brakes on Gondola Cars.—Supplement 2 to Circular 201 of the Southwestern regional director states that 500 U. S. standard hopper cars, allocated to the Pere Marquette, built by the Ralston Steel Car Company, and numbered 13,000 to 13,499, were placed in service without sheave wheels on brake and hand brake pull rod. The circular instructs that, where these cars are found with sheave wheels omitted on the end of the hand broke rod, changes should be made at once, regardless of ownership.

Employment of Apprentices.—The Northwestern regional director, file 42-1-100, states that statistics show that while there are 42,193 journeymen in the mechanical departments of the railroads in this region there are only 1,880 apprentices, or a ratio of one apprentice to 22.44 journeymen. Under the national agreement 6,559 additional apprentices can be employed. The circular adds that diligent efforts should be made to obtain the full ratio of apprentices, and special attention should be given to see that they are thoroughly instructed in the various branches of the trade in order that properly trained mechanics may be provided for the future.

Freight Car Distribution.—Supplement 18 to Circular 70 of the Northwestern regional director contains the following instructions, which are intended to assist in meeting the increased demand for grain cars:

"Effective at once, arrange to give the repair of grain cars preference over other classes of equipment. Additional forces should be employed where they can be used to advantage. Report as of Saturday of each week the number of cars re paired and made fit for grain loading for the preceding wee

"Reports continue to reach me of grain cars used in o service where other equipment is suitable and available less cars are being loaded directly into grain-producin ritory, instructions should provide for the use of non-fit c s From now on special attention must be given to supplying grain cars, particularly for the heavy corn crop, which no demands attention."

Boiler Compounds; Their Nature and Use

Chemical and Mechanical Agents Used to Prevent or Remove Scale; Quantity Required and Cost

BY W. S. MAHLIE

THE question of treating boiler feed water has been one of the most neglected items in railroad operation. The problem of economy and efficiency looms up with greater importance each day. The saving of fuel, the cost of which is no small portion of the operating expenses, has been very forcibly impressed upon railroad men. Outside of actual wastes in poor coal, insufficient combustion, etc., one of the important factors of fuel conservation rests upon the quality of the boiler feed water. In addition to the loss of fuel due to untreated water, there is the cost of the locomotive being out of service, new flues and fireboxes, labor in caulking and washing boilers.

It is not intended in this article to convey the idea that all feed waters should be treated with boiler compounds. By far the most of them should be treated in a regular water treating plant. The cost of treating water by the regular plants and by boiler compounds should be carefully compared and the results obtained from these treatment should also be studied. Boiler compounds are not to be regarded as absolute cures for all boiler troubles. They seldom do more than lessen the bad water conditions, the extent of which depends upon the original water and, of course, the compound used.

It should be kept in mind that a steam boiler was made to furnish steam; not to treat water, consequently the boiler should be supplied with good water so that it can perform the duty which is required of it. A person would hardly drink typhoid germ laden water and then take medicine to prevent typhoid, but rather, would use a pure water which would not produce disease. So it is with boiler water, an ounce of prevention is worth a pound of cure.

Boiler compounds are of many different compositions, some good, some bad, some indifferent. Viewed with the eyes of the practical water purification man, they are regarded as "patent medicines." Like patent medicines they are much advertised and all sorts of good and bad testimonials are recorded following their use. All boilers are not alike, neither are all boiler waters. For this simple reason no compound can be developed which is a sure cure for all boiler troubles. Some may be good for one thing, some for another.

In view of the many compounds sold, I have undertaken in a general way to show their classes, possible reactions, and other data, and let the buyer of the compound judge for himself as to its merits.

Requirements of a Boiler Compound

A successful boiler compound must fill the following requirements: (1) It must make the water non-corrosive. (2) It must hold in suspension, or colloidal form, all of the salts which would give rise to an incrusting precipitate. (3) It must put the water in such a condition as to keep it from foaming or priming. (4) It must be a chemical or compound of such a nature that it can be safely stored and kept from deteriorating. (5) It must be of such a nature that it can be easily measured or weighed and applied. (6) Its cost must compare favorably with other methods of feed water treatment.

It is not known exactly when boiler compounds came into general use. We find that during the development of the oil fields, it was a common practice to put a small amount of crude oil in a boiler to remove scale. Around saw mills it was also a practice to dump saw dust into the boiler to loosen scale. Thirty years ago bran was used in engine tenders to prevent scale in the boilers. Soda ash was used as early as 1864. Thus it will be seen that the use of boiler compounds was more in the nature of an evolution than a discovery.

Purposes for Which Used

Compounds are generally used for either one or more of the three following purposes. (1) To remove and prevent scale. (2) To prevent corrosion. (3) To prevent foaming. Only compounds of the first and second kinds will be considered here because, strictly speaking, the third kind are not boiler compounds, but anti-foaming compounds.

Classification

The boiler compounds may be roughly divided into three classes. (1) According to chemical action. (2) According to mechanical action. (3) According to combined chemical and mechanical action. In the following discussion

the terms temporary hardness and permanent hardness will be used, denoting respectively the bicarbonates of lime and magnesia; and the sulphates, chlorides and nitrates of lime and magnesia. The term incrustants is usually applied to the latter, but most practical men prefer the term permanent hardness.

Class I. Chemical Action

Soda ash or *sodium carbonate* is used more than any other chemical and is the base for practically all boiler compounds. Soda ash usually runs about 98 per cent pure sodium carbonate (Na_2CO_3). Another form known as soda crystals runs about 34 to 35 per cent (Na_2CO_3) the balance being water of crystallization.

The action of soda ash in the boiler is the same as in the regular treating plant outside the boiler. It removes the hard scale or permanent hardness, and neutralizes acids which cause corrosion. Soda ash was used in England as early as 1864. Too much soda ash should be guarded against as it will cause foaming when used in excess.

Sodium silicate or *water glass* is coming into extensive use as a boiler compound. It is seldom applied alone, but most always in combination with soda ash or tannin. Sodium silicate has the advantage of acting on both temporary and permanent hardness. When sodium silicate acts on temporary hardness one part of soda ash or sodium carbonate is liberated for each part of silicate added; this sodium carbonate is then available to act on permanent hardness.

In using sodium silicate the same precautions should be used as in all sodium compounds, since excesses cause foaming. Sodium silicate comes to the market in liquid form.

Sodium hydrate or *caustic soda* is not used as much as formerly and acts on both temporary and permanent hardness and neutralizes acids. Like sodium silicate in its action on temporary hardness each part of it liberates an equal amount of sodium carbonate available for action on the permanent hardness. Caustic soda is not available for removing sulphates of lime and magnesia alone, without the presence of enough temporary hardness, since by the action of caustic soda, hydrates of lime and magnesia are fgormed.

An excess of caustic soda is probably one of the worst things to get into a boiler, because like other soda salts it causes foaming, and has a decided action on brass valves and fittings. It also causes iron to become brittle when in concentrated solution. Caustic soda is bad material to handle, since it takes up water very readily from the air. It burns the skin and clothing, causing very painful sores, which are slow to heal. Caustic soda is sometimes mixed with soda ash and is known as Special Alkali. The approximate composition of this material is 40 per cent caustic soda and 60 per cent soda ash.

Tri-sodium phosphate was formerly used to a great extent, but is not used so much as present. It is distinctly a boiler compound since the reactions between lime and magnesia compounds are not complete at ordinary temperatures, but the water must be boiled in order to obtain the maximum effect. Like the silicate and hydrate of sodium in its action on temporary hardness it liberates an equal part of sodium carbonate, which can be available for further action.

The di-sodium has also been used as a boiler compound. The precipitates of sludge obtained from the action of the phosphates are very light and flocculent, and are easy to blow out of the boiler. It is claimed by some that sodium phospates are the most efficient boiler compounds in use. Sodium phospate was used in England as early as 1879 under the name of Tripsa.

Sodium fluoride is also distinctly a boiler compound. Dr. Doremus patented the use of this chemical as a water softening reagent. One of the claims made for this material is that one-fourth of the theoretical amount required will produce a sludge which will not stick to tubes or the sides of a boiler, and is very easy to blow out. Another advantage claimed is that in using this compound, no volatile materials escape with the steam. No records were to be found anywhere describing the actual success with this compound.

Sodium oxalate has been recommended for use to prevent scale, but no instances could be found where it had been used. The reaction would be upon both temporary and permanent hardness with the formation of equivalent amounts of sodium carbonate.

Sodium chromate can be used to precipitate lime compounds, temporary and permanent. Another peculiar property of chromates is that they render iron passive to corrosion.

Sodium borate or *borax* has been used to some extent as a boiler compound. Lime compounds are precipitated cold, as borates, but magnesia compounds are only precipitated under the heat of the boilers.

In all the preceding discussion, sodium compounds only have been considered. It should be remembered that potash compounds will act in a similar manner, but due to the high price of potash compounds they are not used for this purpose.

Barium salts. In many respects the barium compounds are the ideal boiler compounds, since no soluble alkaline salts are left in solution by their use. On the other hand their cost is much greater, due to the larger amounts required for reactions, and also to the increased cost per pound compared with an equal weight of sodium compounds. In addition barium salts are poisonous and consequently are not desired, even around boilers, where any one might accidentally drink some of the water. Barium salts are ideal for incrusto-corrosive waters having high sulphate content, which otherwise would cause foaming by treating with sodium compounds.

The principal form in which barium is used is the hydrate. The carbonate can be used, but it is said it is not in as extensive use as the hydrate. The aluminate of barium should be a very desirable theoretical treatment, since it would also entangle and precipitate mud and other materials in suspension. Barium hydrate acts on both temporary and permanent hardness and acids. The carbonate of barium is not used much as a boiler compound, but more as a softening reagent in proper chemical treatment tanks. It is also said that barium carbonate is not very satisfactory on magnesium waters.

Lime. It formerly was a favorite practice in the French navy to add just enough lime to boiler waters to make them slightly basic. The lime reacts on the free acids, temporary hardness and magnesium compounds. The introduction of line, however, adds a very bad feature to the acid waters, inasmuch as it will give rise to an extremely hard scale, and the acid is only removed or neutralized at the expense of adding hard scale to the boiler.

The writer has known of one case in particular where the addition of lime to a boiler gave good results. It was during the spring when the periodical acid conditions prevailed in the Ohio river. The flues and fireboxes of locomotives using this water began to leak so badly, that as one boiler maker said, "they wouldn't hold shelled corn." A small amount of lime was placed in the tender of one of these locomotives and the leaking disappeared at once.

Lime comes to the market in two forms, the lump or quick lime, and the hydrated lime. The lump lime is usually the cheapest and an equal weight of it is more efficient than the hydrated lime, since the hydrated lime contains about 25 per cent of combined water. The lump lime, however, becomes air slaked on exposure to air, and is then useless for water softening, while the hydrated lime does not slake. Lump lime runs about 88 per cent pure. When only small amounts of lime are used, the hydrated is probably the best to use, since it can be stored and does not slake. Lime

acts on all free acids, on temporary hardness and on magnesium compounds.

Chalk or Powdered Limestone. The use of this was advocated by the celebrated French chemist LeChatelier. It was introduced to act on sulphate of iron, and to act mechanically by being incorporated with the precipitated calcium sulphate or hard scale. It is not known whether or not successful results were obtained by its use.

Tannin Compounds and Wood Extracts. Tannins are used as scale preventatives in boilers. They are distinctly boiler compounds, and precipitate lime and magnesium as a light bulky precipitate. Tannins are seldom used alone, usually combined with sodium carbonate, sodium hydrate or sodium silicate.

Tannins are obtained from a great many sources, some of them being hemlock bark, oak bark, Canaigre, Quebracho, Palmetto root, Catechu, Gallnuts, Sumac, Valonia and Divi-Divi.

When tannin is used it leaves a very light friable deposit which is easy to remove. It is claimed that tannins are among the safest and best materials to put into a boiler. Some persons object to tannin, claiming that it would cause corrosion. No cases of such action, however, have been brought to light. The different bark extracts are mixtures of tannin and other closely related materials which act in a manner similar to tannin.

According to De Le Coux when a tannin, either free or combined with sodium compounds, is added to water, quite a number of complex changes take place, and the resulting action is that the tannates, gallates, and hydrogallates are precipitated in a mixture.

Zinc and aluminum.. Zinc or aluminum have been introduced into boilers to prevent corrosion. The theory is that zinc and aluminum having a higher solution pressure than iron, will go into solution instead of the iron. This practice of adding zinc was started in 1881. Zinc has been much used, and even today is found in some compounds.

Commander Lyons of the U. S. Navy in 1913 made some interesting experiments on the use of zinc, and found that corrosion was lessened to some extent for a few days, and that then the zinc became coated with an oxide and the electromotive character of the zinc changed, and that instead of the zinc being attacked the iron became attacked. As a result the use of zinc was discontinued and 3 per cent normal alkaline strength of soda ash was used, which gave excellent results.

Sugar, Molasses and Glycerine. It has been claimed that sugar, molasses and glycerine are good scale preventatives, that they dissolve the lime and magnesia salts and hold them in solution, thus preventing a deposit. A number of investigators have studied the action of sugar on lime sals, and found that the oxide is dissolved, and that carbonates and sulphates are little affected. Inasmuch as lime-oxide is not present in boiler water the use of sugar could hardly be recommended. A series of tests was made to determine the solubility of calcium carbonate. Solutions containing one per cent, five per cent and ten per cent of sugar were allowed to act on calcium carbonate, with continuous shaking for 1½ hours. Solutions of glycerine of the same strength were allowed to act in the same way. Identical solutions of sugar and of glycerine were also allowed to act on calcium carbonate by boiling under 18 lb. pressure for two hours. In all cases the solubility was very slight amounting only to traces.

Another series of tests was conducted in a similar manner using calcium sulphate in the different concentrations of sugar and glycerine. It was found that while there was quite an amount of the calcium sulphate dissolved, it did not exceed in any instance the amount normally soluble in water alone. These experiments prove the fallacy of using sugar and molasses as scale preventatives.

Class II. Mechanical Action

Clay. De La Coux says—"Clay is a fairly good scale preventer, but there is danger of clay working into the machinery." It would appear to be a rather peculiar proceeding to add clay to boiler water, because most boiler waters contain clay and other suspended material which it is desired to remove. Clay could have no chemical action, and if added in sufficient quantity to act mechanically it would be almost sure to deposit on tubes and sheets and cause mud burning.

Talc, powdered limestone or *chalk, pumice* and *ground glass* would all act in a manner similar to clay. No advantage can be seen in the use of any of these since they all are inert chemically and they are not of a nature which would appear to benefit scale by being incorporated with it.

Starch, glucose, dextrin, potatoes, slippery elm, artichokes. Any number of materials of a similar character have been proposed. Their action, if any, is entirely mechanical. It is claimed that these substances dissolve in the water and form a sort of gummy gelatinous coating around the grains of deposited scale and prevent them from sticking so tightly together.

Dextrine, starch and glucose are more frequently used as binders in boiler compounds to hold the different constituents together, either in the shape of a ball or a brick.

Ground hoofs and *horns* have been used to prevent scale. When boiled these would yield glucoses and gelatines which would act as before stated.

Oils. The addition of oil to a boiler for preventing scale has been practiced for a long time. The action of course is entirely mechanical. Several explanations as to the action have been made. Some say the oil "rots" the deposited scale. Others say the oil envelopes the precipitated scale and prevents it from sticking. Others say the oil is attracted to the hot tube, becomes overheated, and forms a tiny explosion, which breaks or knocks off the deposited scale.

The benefit of oil addition would appear to be questionable. Christie in his book, Water Purification and Its Use in the Industries, devotes an entire chapter to the subject of oil in feed water, and after describing a number of oil filters says, "The use of oil in boilers to loosen scale is a positive detriment." He further says, "If oil must be used it should be a mineral oil, since animal and vegetable oils will very likely break down, forming free fatty acids and cause corrosion.

The writer, personally, has seen a great many boiler tubes, very badly bagged or blistered, caused by oil in feed water accumulating in a spot and becoming locally overheated. After installation of oil filters the bagging was entirely eliminated. After such experience one would hardly recommend that oil be used in a boiler.

Fats. Fat either alone or mixed with other substances has been proposed and used. It was probably the intention to coat the inside of the boiler with a coating of grease to prevent the particles of scale from adhering to the inner surfaces. No cases have been found recorded where this was entirely satisfactory. It usually caused local overheating where the grease was applied and the hot flame came into contact with the tube. In Belgium the custom has been for some time to rub the inside of the boiler with a mixture of tallow and amorphous graphite.

Rosin and *Tad.* Rosin has been used in a manner similar to fats. When tar was used it was mixed with five parts of oil before being applied.

Graphite. Literature on the use of graphite as a boiler compound is very scanty. After a thorough search, numerous instances were found where graphite was used, but no record of the results obtained were shown.

Graphite cannot be used other than from a mechanical standpoint, in removing scale, since it is inert at ordinary temperatures. The producers of graphite say graphite will

not act chemically, but when the scale is deposited the graphite intermingles with it and prevents it from becoming a compact mass, and keeps it soft and easy to blow out. They also say that the graphite will work through the accumulated scale to the tubes and shell of the boiler and loosen the deposited scale. It is doubtful whether the graphite will do this, but if the graphite were coated on the inside of a new boiler, it would prevent much scale from adhering to it.

W. A. Converse, in an address before the Railway Club of Pittsburgh, May 22, 1914, made the following statement: "It is an absolutely well known fact that there is no possible chemical reaction between graphite and any substance found in boiler feed waters. Any action that might possibly be brought about that might be considered beneficial would have to be of necessity mechanical. It is absolutely impossible for graphite to permeate through any formation in the way of scale of anything like ordinary density. You cannot force it through with a pressure of 60 will probably not permeate the scale in practice in the boiler.

"There is this possibility. If you could get into the lb. I know. If you cannot force it through that way, graphite boiler and with a brush or otherwise polish the interior of the boiler itself as is done on a stove with stove polish, it would possibly smooth the surface of the metal and therefore prevent for awhile the adhesion of the particles of scale. But try to do that on a wet surface and you will find you are up against a very difficult job. And when applied to dry metal, graphite does not last long in contact with water. Consequently it cannot last long in a practical way."

In an article in the Journal of Industrial and Engineering Chemistry, May, 1916, H. K. Benson and O. A. Hougen describe experiments at the University of Washington. They say, "Graphite has no effect in holding suspended matter."

Some time ago a piece of peculiar looking boiler scale or deposit which had been removed from a Stirling water tube boiler was shown to the writer. One of the flues had been burned and upon examination this piece of scale was found. The material was a very hard, black amorphous looking mass. It was also attracted by a magnet. The analysis of the scale showed:

Graphite	None
Silica, SiO_2	1.36 per cent
Magnesium oxide, MgO	3.66 per cent
Sulphuric anhydride, SO_3	21.73 per cent
Calcium oxide, CaO	21.19 per cent
Metallic iron, Fe	50.65 per cent

Upon recalculation to the possible combinations the following remarkable combination appeared:

Silica	1.36 per cent
Magnesium oxide	3.66 per cent
Calcium sulphide	19.58 per cent
Calcium oxide	5.95 per cent
Ferroso-ferric oxide	69.95 per cent

From this analysis it would appear that, first a mixture of calcium sulphate, calcium carbonate, and magnesium hydroxide, with a small amount of silica had deposited in the usual manner. Then due to this sulphate deposit the tube became overheated at this point, not, however, to the maximum. This overheating resulted in a decomposition of the calcium sulphate as shown by the equation.

$$CaSO_4 = Ca_3 + CaO$$

This SO_3 (sulphuric anhydride) then with the water formed an acid which attacked the iron and formed iron sulphate. This iron sulphate with more or less carbon dioxide, formed a deposit of iron hydrates and carbonate. As the deposit became larger the overheating became more pronounced and due to the graphite present, finally assumed very high temperatures. These high temperatures and the graphite reduced some of the iron, so that a mixture of ferrous and ferric oxides was formed, and it happened that they were present in just the proper amounts to form Fe_3O_4.

The temperature attained in this case must have been very high and it readily can be seen that it was very dangerous to operate this boiler. Howver, it is unlikely that another case like this would occur again, especially going to the extremes this one did. However, one can see the danger of having something in a boiler which is liable to deposit on the flues.

Another piece of boiler scale from a stationary engine boiler, which did not carry such a high pressure as the preceding one, was examined. This scale was grayish in color, very friable, and easy to remove from the boiler. Graphite could be seen permeating the scale throughout.

The analysis was as follows:

Water	0.14 per cent
*Ignition loss	18.76 per cent
Silica	3.52 per cent
Iron and alumina	1.38 per cent
Calcium oxide	39.46 per cent
Magnesium oxide	4.99 per cent
Sulphuric anhydride	31.94 per cent
Total	99.19 per cent

*The ignition loss contained about 1 per cent free graphite.

Careful inquiry showed that the scale formation in the boiler was not lessened, however, the scale was changed from a very hard character to a rather soft mushy one. The use of graphite was discontinued in this case as unsatisfactory. These and some other similar experiences have convinced the writer that graphite should never be placed in a boiler to stop corrosion or to prevent the formation of scale.

Class III. Chemical and Mechanical Action Combined

Under this head all kinds of mixtures of the materials described in the preceding pages are used. The following are some actual analyses of commercial boiler compounds:

TABLE I

QUANTITY OF CHEMICALS REQUIRED TO ACT ON THE VARIOUS DETRIMENTAL SUBSTANCES IN WATER

To Act on One Part of	Lime, Ca O	Sodium carbonate, Na_2CO_3	Caustic soda, Na OH	Tri-sodium phosphate, Na_3PO_4, 12 H_2O	Sodium silicate, Na_2SiO_3	Sodium fluoride, Na F	Barium hydrate, $Ba(OH)_2$ 100 per cent	Barium carbonate, $BaCO_3$	Barium chloride, $BaCl_2$, 2 H_2O	Borax, $Na_2B_4O_7$, $10H_2O$	Tannin, $C_{14}H_{10}O_9$
Calcium carbonate as bicarbonate, $CaCO_3$	.560	1.060	.800	2.530	1.220	.840	1.712	.....	.....	3.820	6.440
Calcium sulphate, $CaSO_4$	.....	.786	.588	1.870	.897	.618	1.259	1.449	1.796	2.809	4.735
Calcium chloride, $CaCl_2$	.....	.962	.721	2.283	1.100	.756	1.544	.....	.....	3.441	5.802
Magnesium carbonate as bicarbonate, $MgCO_3$	.660	1.262	.952	3.015	1.452	1.000	2.032	.....	.....	.....	7.667
Magnesium sulphate, $MgSO_4$	.467	.890	.667	2.111	1.017	.700	1.423	1.642	2.036	.....	5.367
Magnesium chloride, $MgCl_2$	.....	1.124	.842	2.666	1.284	.884	1.800	.....	.....	.....	6.779
Carbon dioxide, CO_2	1.272	2.410	1.818	5.757	.....	.....	3.895	.....	.....	.....	.....
Sulphuric acid, H_2SO_4	.571	1.080	.816	2.583	1.245	.....	1.748	2.010	2.492	.....	.....
Hydrochloric acid, H Cl	1.534	2.904	1.096	6.931	1.671	.....	2.443	2.700	.....	.....	.....

Note.—This table is based upon 100 per cent pure materials. These chemicals are rarely over 100 per cent pure, consequently a proportionately larger amount must be used than is shown on the table.

(1) A bluish green liquid, having a strongly alkaline reaction:

Specific gravity	1.40 per cent
Sodium silicate	45.79 per cent
Copper sulphate	1.69 per cent
Iron and alumina	0.17 per cent
Water (by diff.)	53.35 per cent

(2) A greenish yellow solid material, put up in sticks about 1¼ in. by 1¼ in. by 12 in.

Moisture at 105 deg. C.	38.43 per cent
Organic material, presumably tannin and binding material	9.15 per cent
Sodium silicate	7.00 per cent
Alkaline chromate	6.45 per cent
Free metallic mercury	0.62 per cent
Sodium carbonate (by diff.)	38.35 per cent

(3) Volatile—probably spent tan liquor	52.83 per cent
Organic—probably spent tan bark	15.31 per cent
Residue sodium carbonate	30.82 per cent
(4) Moisture	9.69 per cent

(15) Pure graphitic iron and one to four per cent of zinc.
(16) Glycerol .... 15 per cent solution
Oleic acid .... 8 parts
Petroleum .... 20 parts
(17) Zinc and zinc alloys and leather
(18) Benzine, lamp black, animal fat, lard or horse; and tallow.
(19) Graphite .... 50 oz.
Soda .... 30 oz.
(20) "A pulverized carbonaceous material mixed and incorporated with a saline solution."
(21) Sodium phosphate and tannin.
(22) 1 qt. water.
3 lb. whiting.
½ lb. soda (caustic).
½ lb. soap powder.
¼ lb. borax.
(23) Sodium amalgam .... 15 per cent
Tannin .... 10 per cent
Kerosene .... 10 per cent
Whale or seal oil to emulsify.
Caustic soda .... 15 per cent
Dextrin .... 25 per cent
Sodium phosphate .... 15 per cent
Water .... 10 per cent
(24) $C_{10}H^8$,nophthalene) in gasoline or naphtha or other light hydrocarbon oil.

TABLE III

Cost of Chemicals Required to Act on One Pound of Each of the Various Detrimental Substances in Water

To Act on One Pound of	Lime, Ca O, $0.63 lb.	Sodium carbonate, Na_2CO_3, $2.99 lb.	Caustic soda, Na OH, $4.22 lb.	Tri-sodium phosphate, Na_3PO_4, 12 H_2O, $4 lb.	Sodium fluoride, Na F, $17 lb.	Barium hydrate, Ba $(OH)_2$, $33.33 lb.	Barium carbonate, Ba CO_3, $3.55 lb.	Barium chloride, Ba Cl_2, 2 H_2O, $3.50 lb.	Borax, $Na_2B_4O_7$, 10 H_2O, $8.25 lb.	Tannic acid, $C_{14}H_{10}O_9$, $65 lb.
Calcium carbonate as bicarbonte, Ca CO_3	.35	3.17	3.38	10.12	14.28	57.06	.....	.....	31.52	418.60
Calcium sulphate, Ca SO_4	...	2.35	2.48	7.48	10.51	41.96	4.85	6.29	23.18	307.78
Calcium chloride, Ca Cl_2	...	2.88	3.04	9.13	12.85	51.46	.....	.....	28.39	377.13
Magnesium carbonate as bicarbonate, Mg CO_3	.42	3.77	4.02	12.06	17.00	67.72	.....	.....	.....	498.36
Magnesium sulphate, Mg SO_4	.29	2.66	2.81	8.44	11.90	47.43	5.50	7.13	.....	349.16
Magnesium chloride, Mg Cl_2	...	3.36	3.55	10.66	15.03	60.00	.....	.....	.....	440.64
Carbon dioxide, CO_2	.80	7.21	7.67	23.03	.....	129.82	.....	.....	.....	......
Sulphuric acid, H_2SO	.36	3.23	3.44	10.33	.....	57.99	6.73	8.72	.....	......
Hydrochloric acid, H Cl	.97	8.68	4.63	27.72	.....	81.43	9.05	.....	.....	......

Under price per lb., on this table, the materials in Table II have been recalculated to 100 per cent purity basis. All prices are shown in cents. Sodium silicate is not shown on this table on account not being able to secure satisfactory data in regard to percentages of Na_2SiO_3 present.

Metallic aluminum	3.93 per cent
Inert material	71.63 per cent
Graphite	13.75 per cent
This material was claimed to be as follows:	
Aluminum	5 per cent
Graphite	87 per cent
Pumice	8 per cent
(5) Moisture	16.79 per cent
Sodium carbonate	50.72 per cent
Inert material	1.67 per cent
Graphite	9.35 per cent
Organic { Dextrin, Binder }	21.47 per cent

The following is a list of some patented boiler compounds:

(1) 75 parts tri-sodium phosphate.
8 parts ammonium sulphate.
17 parts soda ash.
(2) 6 parts zinc dust.
48 parts soda ash.
18 parts bark extract.
10 parts dextrin.
4 parts graphite.
14 parts water.
(3) Sodium carbonate .... 64 per cent
Tri-sodium phosphate .... 15 per cent
Dextrin or starch .... 1 per cent
Tannin compound .... 10 per cent
(4) 70 parts di-sodium phosphate.
20 parts borax.
10 parts sodium carbonate.
(5) 70 parts sodium phosphate.
20 parts borax.
19 parts calcium carbonate.
(6) Soda ash .... 75 per cent
Meco tannin extract .... 25 per cent
(7) 2 parts H_2O (water).
1 part HCl (hydrochloric acid).
0.01 part Hg Cl_2 (bichloride of mercury).
(8) "An alkaline hydroxide and catechu together with an organic substance containing much water, such as potatoes, are heated until reaction ensues."
(9) Ninety-eight per cent amorphous graphite, with a neutral organic vehicle.
(10) "A solution of saponin, a neutral vegetable oil, such as eucalyptus oil, a basic alkaline salt, and an inactive vegetable colloid preferably carrageen jelly."
(11) Hog lard or horse fat .... 100 parts
Pine soot or graphite .... 3-19 parts
Benzine or a petroleum or mineral oil .... 1-5 parts
(12) "A mixture of soap and acid, nitric and hydrochloric, fat, resin and petroleum oil."
(13) Naphthalene in causic soda, Glaubers Salt (Sadium Sulphate) in ammonia, calcined soda, alum and ultra marine."
(14) "Hydrochloric acid and a solution of bromide in potassium bromide and water. Add a mixture of sodium sulphite, sodium carbonate, or bicarbonate to remove free acid and bromine.

(25) Animal or vegetable charcoal, coal or lampblack in combination with caustic soda or soda ash.

In the preceding tables the items shown are the important points that should be considered in the use of boiler compounds.

Before going into the use of a boiler compound on a large scale, the composition of the compound should be ascertained, and its value in removing the scale and acid materials should be determined. The cost of the compound should be compared with the cost of treatment with lime and soda ash in a regular treating plant. The labor in applying the compound should also be compared with the labor of operating a regular treating plant.

TABLE II

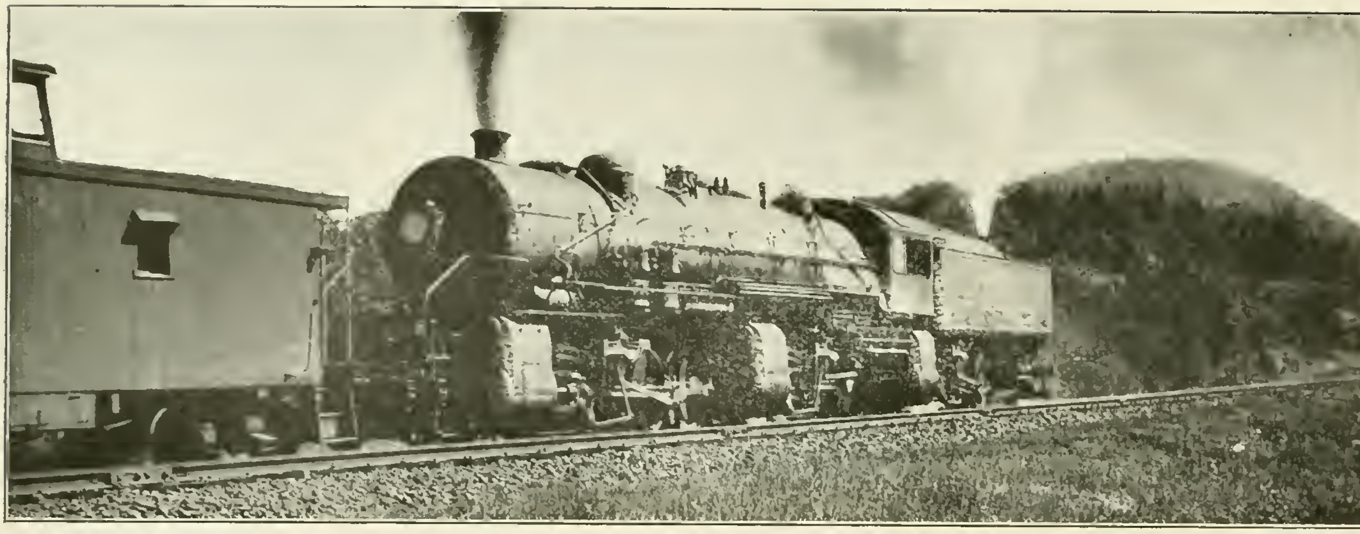
Wholesale Prices of Chemicals in Effect January 1, 1919

Lime, 88 per cent	$11.05 ton
Soda ash, 98 per cent	58.60 ton
Caustic soda, 76 per cent Na_2O	4.15 cwt.
Sodium phosphate	.04 lb.
Sodium silicate, 49 deg. Baume	.02 lb.
Sodium fluoride	.17 lb.
Barium hydrate, 54 per cent	.18 lb.
Barium carbonate, 97 per cent	65.00 ton
Barium chloride	70.00 ton
Boras	.08¼ lb.
Tannic acid (commercial)	.65 lb.

In all cases lowest quotations are given.

It should also be remembered that when using a boiler compound, the only way in which the scale can be removed is by blowing down. Blowing down wastes water and steam which has been brought to boiler temperature at the expense of coal.

No Bolshevism There.—Railwaymen in Southern Italy sent a telegram to the prime minister offering to give the state an additional hour's work a day in order to increase the country's production.—*Great Western Railway Magazine.*



Scientific Development of the Locomotive*

Factors Affecting the Cost of Maintenance and Operation Analyzed and Improvements Suggested

By JOHN E. MUHLFELD

MARKED progress has been made in the development of the steam locomotive as the result of superior engineering ability, and the results have in many respects been exceedingly effective. This progress, however, has been confined largely to an increase in size, weight, evaporating capacity and hauling power, and while the general use of superheaters and firebox baffle walls during the past ten years has substantially assisted in improving sustained boiler capacity and increasing thermal efficiency as well as in keeping the steam locomotive in advance of the electric locomotive, the opportunity for further improvement in thermal and machine efficiency and to reduce smoke, cinders, sparks and noise is untold.

The desiderata in a steam locomotive may be summed up as: a reasonable first cost; maximum capacity for the service within roadway weight, curvature and clearance requirements; ability to handle the heaviest gross tonnage practicable at the highest permissible speed; positive control of mechanical operation; economy as regards fuel and water consumption and repairs; minimum manual labor for road and terminal handling; construction of the least number of parts, and capacity to perform continuous mileage without failure.

> Mr. Muhlfeld describes many radical innovations that are being incorporated in the design of a new freight locomotive and analyzes the defects of present types of construction.

Modern types of steam locomotives fulfill quite satisfactorily all of these requirements, with the exception of wastefulnes in fuel, water and steam consumption, as may be gathered from the fact that the thermal efficiencies now obtained are only from 50 to 65 per cent at the boiler, from 60 to 75 per cent for the combined boiler and superheater, and from 4 to 6 per cent at the drawbar. These as compared with thermal efficiencies of from 3 to 5 per cent at the drawbar of an electric locomotive, 18 to 19 per cent at the switchboard of a modern steam-electric central power station, 25 to 30 per cent for internal-combustion engines, and 40 to 45 per cent as claimed for the full range of from one-quarter to full load for combination internal-combustion and steam motors.

The increase in the first cost and in the cost for labor, fuel, material and supplies for operation and maintenance of the steam locomotive has been most marked during the past ten years, particularly since the war. It is now being operated and maintained by highly paid enginemen and mechanics, with high-priced materials and supplies, and the machine and its performance must be brought up to a more respectable basis of engineering efficiency if it is to be perpetuated.

The supporting data of this paper, which apply to the United States, present the reasons why the general improvement of the steam locomotive should embrace the following changes which are now being embodied in the construction of a new type of locomotive, the first of which it is planned to have in regular service in 1920: *a*, steam at a pressure of about 350 lb. to be employed, superheated about 300 deg. F.; *b*, improved boiler, furnace and front-end design and appliances; *c*, greater percentage of adhesive to total weight, and a lower factor of adhesion; *d*, more efficient methods of combustion; *e*, use of exhaust st[illegible] heater and flue-gas economizer for boiler feedwater; *f* [illegible] team distribution and utilization; *g*, reduced cyl[illegible]ces and back pressure; *h*, lighter and properly [illegible]d reciprocating and revolving parts; *i*, lower heat, [illegible]ictional and wind-resistance losses; *j*, improved safety and time, fuel and labor-saving devices.

Reasons for Perpetuation of the Steam Locomotive

Much more has been said and written during the last few years about the electrification of the steam roads of the United States for the purpose of fuel and labor saving and conservation, but practically nothing has been set forth as to the possibilities to accomplish much greater results per dol-

*Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers. Owing to the length of Mr. Muhlfeld's paper, it is not possible to publish it in full in this issue. The sections dealing with the generation and utilization of steam will appear in next month's issue.

lar of investment and operating cost by a scientific development of the steam locomotive. As the average use of power at any considerable load factor is for only 8 hours per day, and as there is more or less irregularity in the demand, due to the small use on Sundays and holidays, the available water power would be used only about 2,400 out of possible 8,760 hours per annum, or about 27 per cent of the time, so that the remaining 73 per cent would be wasted. Therefore, where continuous water power is available it should be diverted to the special requirements of large and regular amounts, such as in electro-chemical and metallurgical processes, in order that this waste may be reduced to a minimum.

The methods at present employed for generating electric power from fuel in large modern central power stations represent from 18 to 19 per cent thermal efficiency, and as the investment cost for a steam plant is from one-third to one-quarter of that for a water-power development, the same total investment would produce from three to four times as much power from a steam plant as could be secured from a hydroelectric plant.

Complete electrification of some portions of the large transcontinental trunk lines has been effected, all of which are representative of progressive engineering skill, but reliable reports and statistics available have not proven the actual operating economies predicted, and with the present unsettled state of the electrical art numerous objections present themselves, among which may be noted: *a*, prohibitive capital and non-productive cost per mile for road, equipment and facilities; *b*, non-interchangeable equipment adaptable to certain electric zones only; *c*, entire operation dependent upon single power plants and transmission systems; *d*, widely varying load factors—dependent upon business conditions—requiring enormous outlay to meet uncertain peak movement and emergency conditions; *e*, complication and congestion of road and terminal trackage with transmission and contact lines; *f*, first cost from five to ten times, and operating cost from two to three times that of steam; *g*, liability for complete tie-ups due to storms, snow, sleet, rain and short-circuits.

Any general plan to electrify the steam roads to meet other than terminal and trunk-line congestion conditions, at an absurd cost, would mean lack of efficiency and prohibitive financing, which would result in bankruptcy for most of the railroads affected and in a further burden upon the public. In fact, it would be a source of real danger to the rehabilitation of these transportation systems, as to discard steam locomotives where coal or oil is available and can be burned with efficiency, comfort and economy, represents absolute waste.

Proposed Order of Development of the Steam Locomotive

The opportunity for steam locomotives to produce economy by increasing train loads, reducing transportation and mechanical delays and saving fuel and labor, is enormous.

The principal parts of a steam locomotive assembly are the boiler, engine, running gear, tender and special appliances, and the functioning of these parts in operation, jointly or independently, will involve particular factors that are capable of scientific development, viz.:

1 Design, Material and Workmanship.
2 Adhesive Weight, Tractive Power and Factor of Adhesion.
3 Tracking, Curving and Riding.
4 Boiler Feedwater
5 Boiler-Feedwater Purifying.
6 Fuel.
7 Combustion.
8 Boiler Water Circulation.
9 Heat Radiation, Convection and Conduction.
10 Steam Generation.
11 Steam-Pressure Increase.
12 Steam Superheating.
13 Steam Distribution and Utilization.
14 Waste-Heat Distribution and Utilization.
15 Friction and Resistance
16 Acceleration.
17 Deceleration.
18 Lubrication.
19 Insulation.
20 Safety Appliances.
21 Special Appliances.
22 Power for Accessories.
23 Time Saving.
24 Fuel Saving.
25 Labor Saving.

The supporting data relating to the improvement of these factors are presented below:

Design, Material and Workmanship

Only by greater refinement in construction can requisite operating results be produced to offset the increased cost of equipment supplies and labor. Therefore the designing should now be done along more scientific lines through the substitution of boiler, cylinder and drawbar horsepower and drawbar pull calculations for tractive power; thermal efficiency for evaporation results; distributed for centralized thrusts, strains and stresses; light, high-grade alloy and high-carbon steels and other metals for heavy, low-grade plates, forgings and castings; and in the more general use of high-grade engineering practice in lieu of rule-of-thumb methods.

In the modern high capacity locomotive it is necessary that certain parts be made as light as possible. On the other hand, the items of fatigue and shock of metals due to continued vibrations and impact as well as of inherent combinations of weakening chemical and physical characteristics, are responsible for many sudden failures of staybolts, plates, springs, axles, crankpins, tires, piston and main rods, frames and like parts that are subject to reversal of stress or to hundreds of thousands of repeated and localized loads. As it has been found that the elastic limit is not necessarily representative of the fatigue strength, these factors require that further careful research and study be made for the purpose of determining upon a reliable quick test that will insure against unsuitable material entering into the construction.

The same degree of refinement applies equally to workmanship for construction and upkeep, which should be brought up to the same standard as obtains in other machinery that is producing more efficient and economical power for other modes of travel.

Adhesive Weight, Tractive Power and Factor of Adhesion

Adhesive Weight. In the ideal locomotive all of the weight is carried on the driving wheels for utilization as tractive power. The extended use of non-productive trailing wheels and the four-wheel leading truck has become an expensive fashion in that it has greatly reduced the percentage of total engine weight on drivers for adhesive purposes. For example, where a modern Mikado type locomotive will average 75 per cent adhesive to total engine weight, a modern Consolidation will run as high as 92 per cent, thereby utilizing much more of its weight to produce drawbar pull, hauling power and earning capacity.

Boiler design and weight distribution should be so correlated to the running gear as to make the use of trailer wheels unnecessary except where required by wheel load limitations, and with the more recent improvement in constant resistance leading truck designs any four-wheel arrangement, except for high-speed passenger service, should be entirely satisfactory.

Tractive Power. In calculating tractive power the usual practice is to use 85 per cent of the indicated boiler pressure in lb. per sq. in. for two and three-cylinder single expansion, and 52 per cent for two and four-cylinder compound engines. However, for a superheated steam locomotive the use of a higher percentage of the indicated boiler pressure should receive due consideration when making tonnage rating schedules before the train load is finally determined upon, as dynamometer tests have indicated that as high as 92 per cent for two-cylinder single expansion locomotives is permissible for train-loading purposes.

Factor of Adhesion. In the same way that the leading

and trailing truck type of locomotive has reduced the percentage of adhesive weight, so also has it increased the factor or ratio of adhesion, due to the "bridging effect" thus obtained over the driving wheels, tending to release the weight on the latter. Whereas many successful Consolidation types of locomotives are now operating with factors of adhesion of from 3.55 to 4.0, the Mikado types will usually range from 4.0 to 4.5. The co-efficient of static friction or adhesion between driving wheel tires and very dry, clean rails reaches a maximum of about 0.35, and for moist, muddy, greasy and frosty rails a minimum of from 0.15 to 0.20, giving factors ranging from 2.85 to 6.65.

In general, the factor of adhesion should be as low as practicable in order that the maximum power will always be available to start trains that can be easily handled when in motion and should about equal the ratio between the limiting friction in pounds and the weight on driving wheels in pounds, which for average dry rails is from 3.5 to 4.

Tracking, Curving and Riding

With the increased length, higher center of gravity, extended front and back overhang, and smaller proportion of spring-borne weight there have been many difficulties to overcome in order to maintain proper tracking, curving and riding qualities in locomotives of great power, and in the majority of cases these have been met with unusually satisfactory results.

Certain changes can be made, however, that will bring about a general betterment in the way of reduced rolling, oscillation, nosing and pounding, namely, reduced spread of cylinders; more uniform distribution and equalization of weight over driving and truck wheels; maximum permissible diameter of driving wheels; reduction in weight of revolving and reciprocating parts and counterbalance and proper distribution between wheels; improvement in constant-resistance lateral-motion devices; more uniform cylinder pressures when using steam and drifting; and greater refinement in control of end play, wheel and rail clearances, and tire-tread coning.

As the centrifugal power force of surplus counterbalance, the swinging movement of spring-borne weight and the rotative force on the crankpins are constantly changing in combination with speed and cut-off, the importance of giving particular attention to all of the foregoing cannot be overestimated.

Friction

Friction. Friction due to oscillation, concussion, rolling, wheel flanges and treads, journals, cylinders, valves, valve gear, crossheads, center and side bearings, coupler side play and the like absorbs a considerable percentage of the power developed by the steam.

Maximum machine efficiency, or ratio of drawbar to indicated horsepower, is usually obtained at speeds of from 25 to 50 miles per hour and ranges from 80 to 85 per cent, above which speeds, due to increased friction, it gradually decreases to about 70 per cent at 75 miles per hour. For example, with a locomotive developing about 2,000 hp. at a speed of 30 miles per hour, about 325 hp. would be lost in internal or machine friction.

During the past ten years the increased rigid wheelbase and axle loads, greater lateral rigidity, larger cylinders, valves and revolving and sliding bearings, substitution of grease for oil lubrication, and greater number of frictional parts, have tended to increase the machine friction and consequently the horsepower, drawbar pull, the steam and fuel losses.

All of these are factors that should receive proper consideration in new designs.

Resistance

Resistance. Other than the resistance resulting from machine friction, the locomotive is subject to those due to grades, curves, weather, wind and head air, which latter is more particularly affected by the general design. As the horsepower required to overcome front air pressure increases with the cube of the speed plus the resistance due to the "air in motion," reduction of transverse flat surfaces, smoothing off of projections, vestibuling of openings and use of general curves parallel to the natural flow of the air should be carefully considered in high speed locomotives, particularly in view of the high fuel consumption and machine friction and the relatively small proportion of drawbar pull available for hauling trains at high velocities.

While the complicated design of a steam locomotive, particularly as regards the application of its accessories, makes the use of relatively smooth outside surfaces generally impracticable, still much has been done along this line on some of the European railroads that can be adopted by us to good advantage.

Acceleration

As the train resistance increases and the drawbar pull of the locomotive decreases due to speed, acceleration, rapidly becomes a diminishing quantity. Therefore in order to expedite train movement, locomotives should be designed and adjusted so as to permit of the highest possible rate of acceleration in the shortest distance after starting, in order that the maximum desired running speeds can be reached in the minimum of time during which the greatest evaporating capacity of the boiler is available. In locomotives designed with trailer wheels a great deal of otherwise available adhesive power, particularly for starting and acceleration purposes, is being wasted and the utilization of this lost adhesive weight by the elimination of trailer wheels, or by the application of an independent means of power for their propulsion, would accomplish a great deal in the way of starting and accelerating trains to speeds of from 15 to 20 miles per hour.

Deceleration

Deceleration is as much a factor in expediting train movements as acceleration, particularly with long and heavy trains and grades, and improved brake-shoe design, material, flexibility and bearing area in combination with clasp types of brakes for all wheels would do much toward providing greater stopping control over large and high speed steam locomotives and thereby avoid the necessity for resorting to the use of the engine cylinder back pressure to produce adequate braking power without liability for skidding and flattening the driving wheels.

Lubrication

Valve Oil. The usual method of feeding valve oil is through a steam-condensing lubricator. However, this method gives an irregular feed of oil to engine valves and cylinders if no change is made in the adjustment of the sight feeds when the locomotive is at rest, working with a light or a full throttle, or drifting. With high steam pressures and superheat a suitable automatic force- food lubricator, located near the steam chests, with individual feeds to engine valves and cylinders and adjusted to insure a positive and uniform feed of 50 per cent of the oil to each of the valves and cylinders at all times when the locomotive is moving, will unquestionably give better results.

Piston and valve rods equipped with a suitable aluminum-zinc lead alloy metallic packing should not require lubricators or swabs except on roads where a high percentage of drifting obtains.

Superheat valve oil is unnecessary, as carbonization of oil is due to air admission to engine valve chests and cylinders when their temperature is greater than the finish point of the oil used and is also aggravated by the induction of gas and cinders through the exhaust nozzle.

The results of tests made to determine the respective coefficients of friction of oil and grease-lubricated journals

show the former to be about 0.02 and the latter about 0.03 Therefore, while the internal or machine friction of the modern locomotive has been considerably increased due to the use of solid lubricants in combination with relatively high bearing pressures, and the wear on these frictional surfaces has been materially increased, grease has nevertheless protected bearings that would otherwise have heated, and its use will no doubt be continued until a satisfactory automatic force-feed method of oil lubrication is devised.

Machinery Oil This is the ideal lubricant for wearing parts not subjected to excessive concentrated pressures and temperatures, and should be employed wherever a better distribution of the work, proportion of parts, or method of application will permit of its use. There is opportunity for much to be accomplished in the development of a more satisfactory and automatic means for its application.

Insulation

The loss of heat through radiation justifies a considerable expenditure for its prevention, and the most practical method for reducing this waste is to first design and locate the heat-transmitting parts so that they will be the least exposed to the surrounding atmosphere and to then make use of a good non-conducting lagging, properly applied.

With the available non-corrosive heat-insulating materials that can now be readily molded into sectional blocks to any form and size desired for ready application and removal, and which will withstand the disintegrating effects of heat, vibrations and concussions incident to modern locomotive operation, there is no good reason why boilers, fireboxes, steam pipes, valve chests, cylinders and heads, air pumps and other heat-radiating accessories or parts should be left exposed in the way they generally are, with the resultant steam and fuel losses.

Safety Appliances

While the annual reports of the Interstate Commerce Commission on personal injury accidents chargeable to locomotive equipment indicate that considerable remains to be done to improve safety with respect to boiler fireboxes, staybolts, flues, tubes, plugs, studs, blow-off cocks, water gages and grate shakers; injectors and connections; lubricators; squirt hose; reverse gears; main and side rods, and draft gear, a great deal in this direction has been accomplished during the past seven years through the co-operation of the railroads and the locomotive and equipment builders with the Interstate Commerce Commission inspectors.

Special Appliances

Tender Trucks. The present use of staggered instead of square rail joints in track laying results in considerable vibration and surging of tenders when first-class track surface and alignment are wanting. This derailing action necessitates the use of a flexible type of tender truck, such as will make it possible for each wheel to always follow and remain on the rail with which it is in contact without regard to any other wheel in the truck, if liability to derailment is to be avoided.

Truck Wheels. According to the reports of the Interstate Commerce Commission there were 954 derailments on the steam railroads during the year 1917 that were due to broken flanges and broken and burst wheels; these caused damage to railroad property amounting to $1,132,030, and resulted in the killing of 16 and the injury of 72 persons. While these reports apply to both locomotives and cars, still they indicate the urgency for improvement.

With increasing wheel loads and speeds and higher and longer braking pressures the chilled-iron and cast and forged steel wheels must not only be of the best design material and construction to meet the most severe requirements with a proper degree of safety, but the weights should be reduced to an economical maintenance and operating basis. Chilled iron and forged steel wheels have become particularly notorious with respect to non-productive deadweight resulting from unsuitable or surplus metal, or both, and necessity will now demand an early betterment.

Mechanical Stokers. Reports indicate that stoker-fired locomotives burn from 10 to 40 per cent more coal than those hand fired, which includes the additional coal used for operating the stoker equipment, and that the cost for stoker repairs ranges from 2 to 4 cents per locomotive mile. Also that failures occur due to broken stoker parts, foreign matter in coal and wet coal. The kind and preparation of fuel are also items of importance, particularly as relating to low-volatile bituminous and anthracite coal.

It is doubtful whether any considerable progress in efficiency or economy will be made in the stoker firing of locomotives in combination with the limitations now imposed by burning coal on grates or in retorts with forced draft, and this is a matter of the greatest concern in the economic development of the steam locomotive.

Air Compressors. Compressed air is one of the most expensive mediums for producing power, particularly when the compressing is done by the single-stage system which is still in use on the majority of locomotives. As the steam is used at long cut-off and the heat of compression is dissipated and represents lost work, an average of from 70 to 85 lb. of saturated steam at 200 lb. pressure is required per 100 cu. ft. of free air compressed to from 100 to 130 lb. pressure.

For air pressures of 100 lb. and over a cross-compound steam and two-stage air compressor with intercooler between the air cylinders should be used. This will easily give an equivalent compressed-air production on from one-third to one-fourth of the steam consumption which results can be further improved by the use of superheated steam.

Main-Driving-Axle Boxes. These are the seat of one of the serious deficiencies in locomotives of great power. As any change in the alignment of the main driving axle or an accumulation of lost motion therein immediately affects the movement of the directly or indirectly connected main and inside rods, valves and pistons, it is most important that this axle be kept in close adjustment at all times. Increasing the length of driving boxes and the various means devised for applying and adjusting the crown bearings, hub plates and shoes and wedges have not yet produced the required result, and considerable opportunity for improvement still remains.

Lateral-Motion Devices. Restricting the lateral movement over leading and trailing truck and driving wheels as well as in tender trucks has been responsible for many derailments and much wheel-flange and rail resistance and wear, particularly with modern designs of locomotives of long wheelbase and high center of gravity. Promising results have obtained from the development of constant-resistance lateral-motion devices, but further improvement is needed along these same lines to meet the more extended rigid-wheelbase conditions.

Throttle Valves. These should be removed from the boiler where they are now an obstruction to making boiler inspections and are inaccessible for inspection, adjustments and repairs.

Power for Accessories

The steam locomotive must not only produce superheated steam for the development of drawbar pull, but also supply saturated steam to various accessories of its own and for train operation. Not only has the use of compressed air been found to be most expensive for the working of these accessories, but the reserve supply for train braking has been frequently drawn upon for their operation. As power reverse gears, fire doors, water scoops, coal pushers, ashpan doors and like devices can be equipped for steam operation, such substitution offers possibilities for less drain on the boiler and much needed economy in the cost for this auxiliary power production. Moreover, as all of this power for accessories is produced by saturated steam, some means for sub-

stituting the use of superheated-steam for those purposes where it is more suitable and economical should be given due consideration.

Time Saving

The principal time-saving factors other than speed reductions and stops necessary to take on and set off business and to meet roadway, train-despatching and operating requirements, may be stated as: *a*, acceleration; *b*, deceleration; *c*, mechanical road delays; *d*, mechanical terminal delays; *e*, fueling; *f*, watering.

Acceleration and Deceleration. Much time is to be gained in quickening the starting and stopping of locomotives. Any engineer who has noted the length of time usually taken to get a passenger, freight or switching locomotive, either light or loaded, under headway and to reduce the speed for a stop, will appreciate what this may amount to.

Mechanical Road Delays. These may be classed as due to engine, fuel, water and man causes.

With the adaptation of locomotives best suited for regional requirements and with proper improvements in design, material, construction, inspection, testing and upkeep, "engine causes" can practically be eliminated.

Through the installation of modern fuel-preparing facilities, provision for adequate tender capacity, adaptation of locomotives to utilize the most inferior and cheapest fuels available, use of simplified manual means of firing, and particularly by reducing the consumption required per boiler horsepower developed, the "fuel causes" can be substantially reduced.

The proper systems and time for washing out boilers and the supplying of suitable, treated if necessary, boiler water to adequate tender tanks will dispose of "water causes."

"Man causes" can best be avoided through the employment of competent men, the inauguration of proper systems for education and instruction, and by equipping locomotives so that they will require the least amount of arduous work.

Mechanical Terminal Delays. These are due principally to sanding, ashpan and fire cleaning, fire building, boiler washing, firebox, flue and smokebox cleaning, inspection, testing, machinery cleaning and repairs. Of these delays those due to ashpan, fire, firebox, flue and smokebox cleaning are the most prolonged and non-productive and can be reduced only by improved methods of firing, reduced fuel consumption per unit of work performed, and substitution of mechanical appliances for arduous labor, so that upon arrival at terminals locomotives can be run directly into the enginehouse instead of being held outside for this class of work and delaying upkeep attention.

Fueling. Many facilities for fueling locomotives, either with coal or oil, are obsolete, inadequate and uneconomical. Fuel should be prepared ready for firing before being placed on tenders, and with modern facilities practically no time should be lost in supplying, either on the road or at terminals.

Fuel Saving

The problem of locomotive fuel saving has never received more intelligent thought and attention from a supervising standpoint than during the past two years. This has been due to the war-time necessity for the conservation of both the fuel and the labor required for its production and to the fuel cost reflecting a constantly increasing percentage of the total expense for railroad operation.

While the furnishing of coal or oil of a proper kind and preparation) by an intelligent, trained and careful fireman to a locomotive in good working order and properly operated should result in effective and economical performance, the vast difference in the amount of fuel actually used by different train despatchers, engineers, firemen and locomotives to produce the same ton-mile movement under like transportation conditions indicates the necessity for reducing the amount of fuel to be fired per ton-mile by effective mechanical means and methods instead of depending upon the directly involved and responsible human element for equivalent results.

There is no questioning the fact that avoidable low boiler and mean-effective cylinder pressures, saturated steam, indifferent boiler circulation, excessive firebox draft, clogged grates and boiler and superheated tubes, forced combustion, high smokebox temperatures, unnecessary non-adhesive weight and generally indifferent steam generation, distribution and utilization factors, for which the engineer and fireman are not responsible, have more to do with high fuel and water rates than those factors within their control. Therefore the proper procedure, particularly in view of the relatively small increase in cost for the improved locomotive equipment as compared with the total locomotive cost and the reduced expense for its upkeep and operation, is to design and equip the modern steam locomotive so that it will more fully utilize the thermal heat value of the fuel and not be so dependent upon the manual control to bring the fuel used for productive work within the proper limitations.

Making initial capital and continual upkeep and operating expenditures in order to provide well-known inefficient and uneconomical mechanical means for handling, firing and wasting greater quantities of fuel than are within the easy range of one-man hand firing, in preference to diverting an equivalent amount of money for capacity increasing and fuel and water-saving appliances, represents a policy that is not at all consistent with existing and future labor and fuel costs if the railroads are to be continued on an investment basis.

Labor Saving

The labor now required for the upkeep, terminal handling and operation of the steam locomotive is divided into three classes, i. e., shop and enginehouse men, hostlers, cleaners and supply men, and enginemen.

The item of maintenance is distributed between general and running inspection, testing and repairs and is taken care of at the shops and enginehouses, respectively. During the past fifteen years a great deal of attention has been given in the planning of these facilities to provide labor-saving tools and machinery for dismantling, repairing and assembling locomotives and appurtenances, and there are to-day many conspicuous examples of modern railroad shops and enginehouses, even though many more are needed.

Great progress has been made in the establishing of adequate and suitable terminal handling, cleaning and supplying facilities which now include power-operated coal, sand and ash handling plants and turntables, high capacity water cranes, hot water boiler washing and locomotive cleaning systems, steam and compressed air stack and flue blowers and similar appliances. The cleaning and dumping of fires, ashpans and front ends and the rebuilding of fires is, with the increasing size of locomotives and the use of inferior coal, becoming a matter of great concern, delay and expense in the terminal handling, particularly during congested traffic and cold-weather periods, and a satisfactory solution of this problem still remains to be provided.

In the operation of locomotives the hours of service law established the general practice of pooling locomotives and crews, which system until that time had been adopted by only a few of the railroads. The divorcing of the engineers and firemen from regularly assigned locomotives, in combination with the increasing size of the latter, resulted in relieving the enginemen of work which was transferred to the enginehouse forces. This change, in combination with the more extended use of power-operated auxiliaries, has practically eliminated arduous manual operation on locomotives of great power.

The mechanical requirements and status of the engineer and fireman on the large steam locomotive having been substantially changed, there should now be a resulting higher standard of operation, efficiency and economy.

A Five Car Train on the Manchester-Bury Line

ALL-METAL ELECTRIC MULTIPLE UNIT CARS

The Lancashire & Yorkshire, England, Built During the War Interesting Equipment for Its Manchester-Bury Line

BY ROBERT E. THAYER
European Editor of the Railway Mechanical Engineer

THE Lancashire & Yorkshire Railway was the first main line railway in Great Britain to adopt electric traction for its suburban steam service. Its first project was that of converting the Liverpool-Southport line, and later the line from Sandhills Junction to Ormskirk, the two projects involving 38 miles of track with an equivalent of 80 miles of single track, including sidings. The Liverpool-Southport line was opened to traffic in March, 1904. The multiple unit system of train control was adopted for this line with two 150 hp. motors on each truck, operating at 600 volts direct current, the power generated being 3-phase, 25 cycles alternating current at 7,500 volts.

Interior of First Class Smoking Compartment

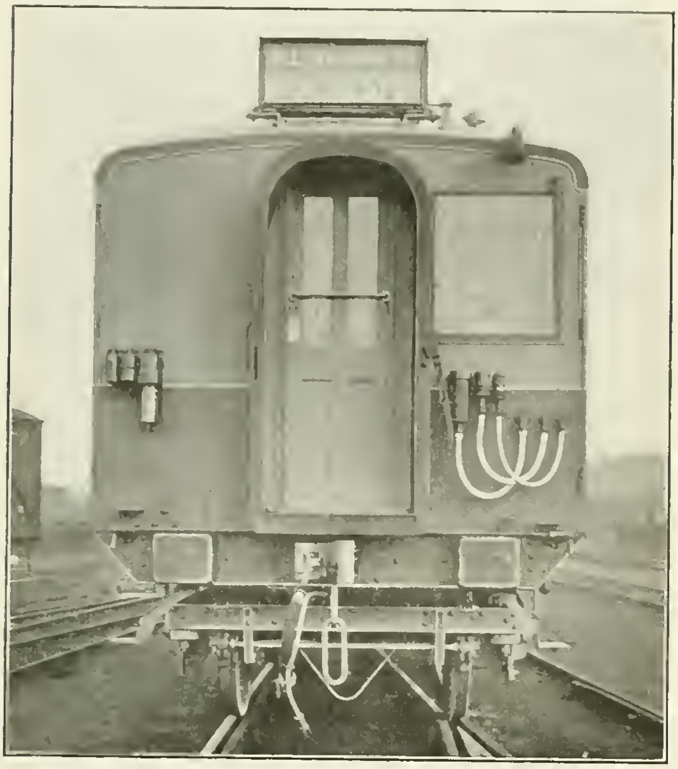
This electrification scheme has met with great success. Passenger business has been constantly on the increase ever since the line was put into operation. Whereas there were four lines required in certain parts of this electrified line for steam service, under electric service two lines are sufficient to handle the traffic, although the frequency of trains has been more than doubled. In this way the widening and laying of additional lines through an extensive territory, which would have been required had steam working been retained, has been eliminated.

On the Liverpool-Southport line, which extends to Crossens, there are 14 intermediate stations which lie at an average distance of less than one mile apart on the southernmost portion and are more widely separated on the northern portion. There were about 36 trains a day in each direction between Liverpool and Southport under steam operation. This number has been increased to 70 under electric operation. The total train mileage per day under steam operation was about 1,900. This has been increased to 3,500. The running time from Liverpool to Southport, which was 54 minutes under steam operation, has been decreased to 37 minutes. The express service between Liverpool and Southport has been increased from four trains per day to ten.

During the first year of the electrification of this line 14 per cent more people were carried, with a reduction of from 78,393 tons to 69,160 tons in the total weight of rolling stock moved per day.

It was the excellent results obtained from this service that

lead to the electrification of the Manchester-Bury section of that same road, which was opened for service in February, 1916. This line runs from Manchester via Prestwich to Bury, and from thence to Holcombe Brook, which is 13¼ miles from Manchester. The line has rather heavy grades

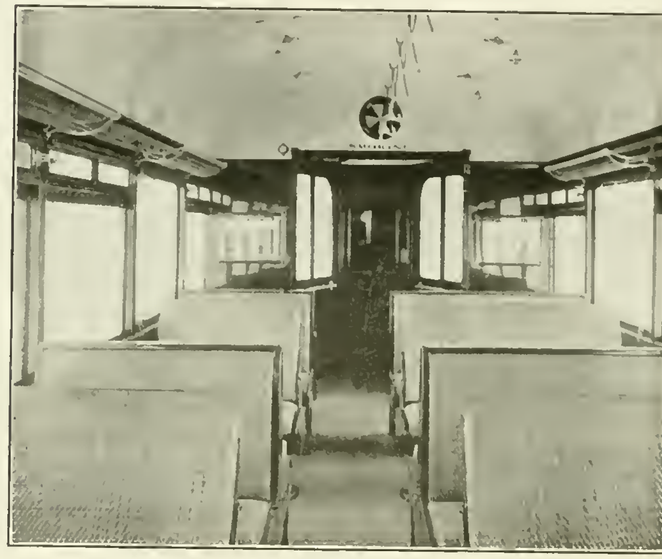


End View of Trailer Car

with several grades over 1 per cent and three of 2 per cent or over. The heaviest grade is 2.4 per cent for a little less than a mile. There are 14 intermediate stations on this line between Manchester and Holcombe Brook. As in the case of the Liverpool-Southport line, this line uses the multiple unit train control system, but the driving current is 1,200 volts direct current instead of 600, and the cars are equipped with four 200 hp. motors, as the grades on the Manchester-Bury line are much heavier than on the Liverpool-Southport line. As in the case of the Liverpool-Southport line, the number of trains on this new line has been greatly increased.

Lancashire & Yorkshire Motor Car

Profiting by the experience obtained on the Lancashire-Southport electrification, a new design of motor car and trailer was developed for this new project. On account of the heavy gradients, and further, to permit of as rapid acceleration as possible due to the large number of stations on the line, a careful study was made to make these cars as light as possible and still retain sufficient strength to meet



Interior of Third Class Smoking Compartment

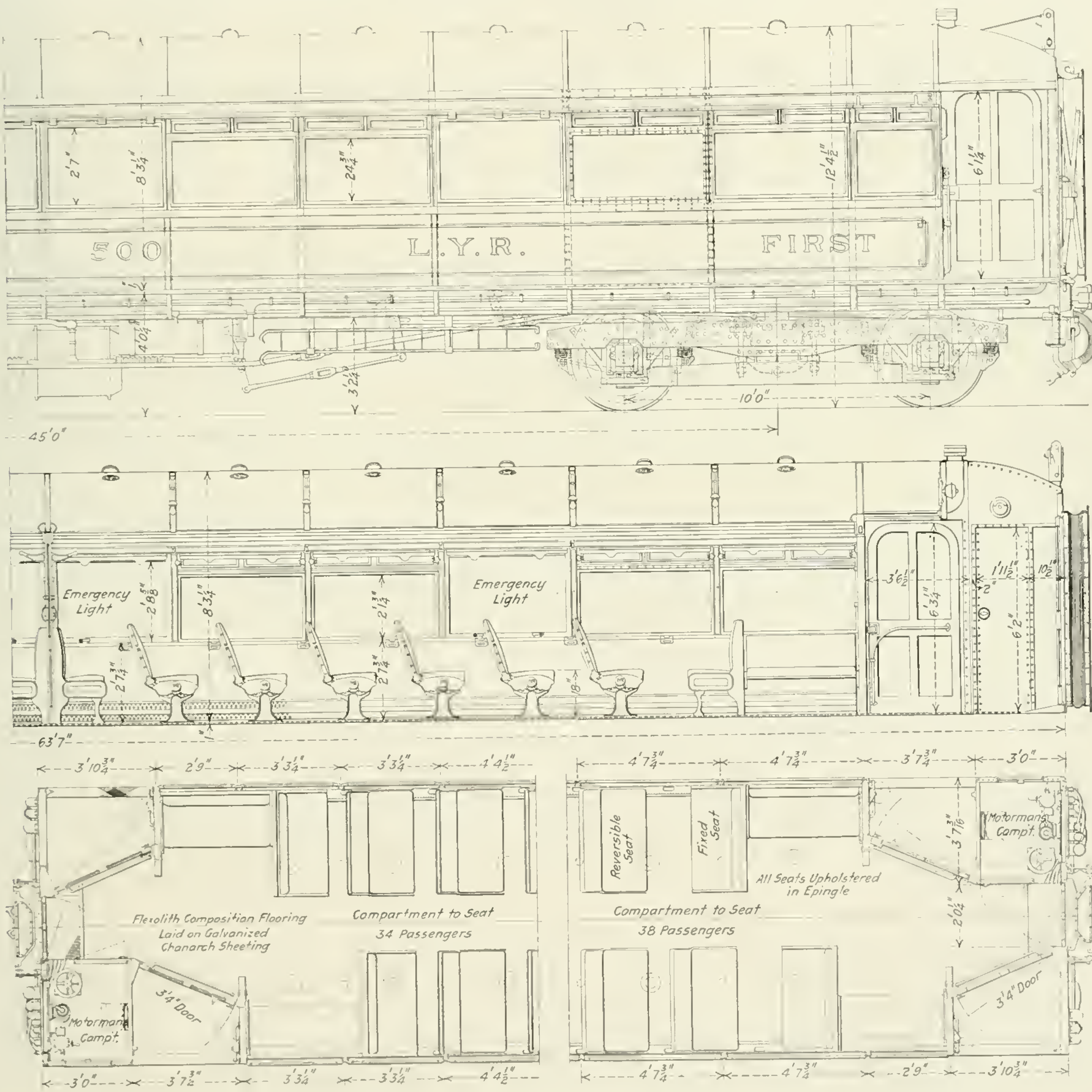
all service conditions. Whereas the Liverpool-Southport cars are built of wood and metal, the new cars are built entirely of metal, alloy steels and aluminum being used to a considerable extent in an endeavor to keep the weight down. By using aluminum instead of steel plate, the weight of the cars has been reduced 1,623 lb. These cars are the first all-metal cars to be built for main-line service in Great Britain. Forty-six of them were built three years ago at the railway shops of the Lancashire & Yorkshire with the same force of men that had previously been used in the construction of the wooden cars, and no difficulty was experienced in adapting these men to the new materials involved in the

construction of the all-metal cars. These cars are divided into three classes—the motor car, which is always third class and is provided with a baggage department, and first and third-class trailers.

Contrary to the usual British practice of compartment arrangement, these cars were built with the open aisle similar to American practice and in accordance with the design used on the Liverpool-Southport line. In commenting on this arrangement Sir John A. F. Aspinall (general manager of the road at the time the electrification was adopted) stated doors are used, and, in fact, in the design of these cars the side framing has been calculated in as a supporting structure.

Comparison of Car Weights

The motor cars weigh unloaded 120,960 lb. These cars carry third-class passengers and have a baggage compartment. They have a seating capacity for 74 passengers, which gives a total unloaded weight per passenger seat of 1,634 lb. This compares with 2,206 lb., the weight per passenger of similar sized motor cars of composite construction.



Plan and Side Elevations of First Class Trailer Car

in his presidential address before the Institution of Mechanical Engineers that with this arrangement the trains can be handled at stations much more quickly than with the compartment coaches having the side doors. "The most crowded cars are always emptied during rush hours in about 50 seconds at terminal stations, while intermediate stops only require 15 seconds to pick up and set down passengers." He also said, in favor of this arrangement, that greater strength can be obtained with such construction than where the side

The third-class trailer cars, which are provided with motormen's compartments on each end, but which carry no baggage, have an unloaded weight of 64,960 lb. These have a seating capacity for 95 passengers, which gives an unloaded weight per passenger seat of 683.7 lb. The third-class cars are provided with seating space for five people across the car—that is, three passengers on one large seat on one side of the aisle and two passengers on the other.

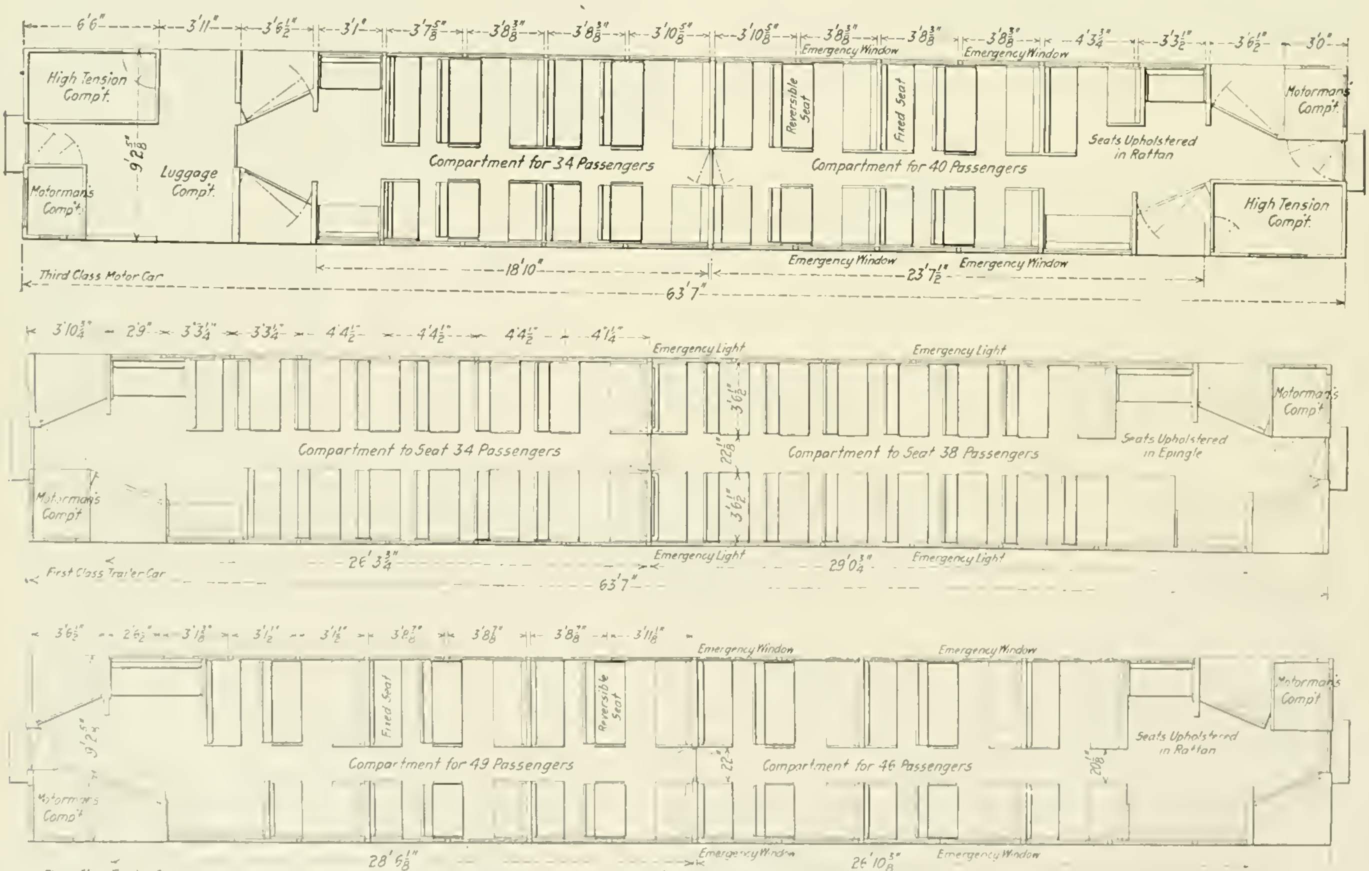
In the table is given a comparison of the principal dimen-

sions of the all-metal cars with the composite cars in use on the Liverpool-Southport line and with the all-steel cars in use on the Long Island in the United States. Comparing these trailer cars with those in use on the Long Island Railway, it will be seen that, whereas the Long Island cars are practically the same length, they have a width inside the body of 9 ft. 4½ in. as compared with 8 ft. 11½ in. on the Lancashire & Yorkshire, and they have a seating capacity for 80 passengers as compared with 95 on the Lancashire & Yorkshire cars. The Long Island cars weigh 63,100 lb. or 1,860 lb. less than the Lancashire & Yorkshire cars, but on account of the seating capacity, due to the fact that the seats provide for only two passengers, the weight of the car per seat is higher, being 788 lb. as against 683.7 lb. for the Lancashire & Yorkshire. The width of the aisle in the third-class coaches with the three-passenger and two-passenger seats is 1 ft. 8⅛ in., and while that appears to be rather narrow, no great difficulty is experienced in passing down the car. Furthermore, the interior arrangement has been carefully studied and practically every inch has been utilized for seating capacity. A study of the floor plans of the motor, the third-class and first-class trailers gives an indication of this. In comparing the all-metal trailer cars with those in use on the Liverpool-Southport line, it is to be mentioned that the latter cars have a motorman's compartment on one end only and that the Manchester-Bury all-metal trailer cars have underframes of sufficient strength to permit of motor trucks being used. In addition, more brake work is included on the all-metal cars. It has been calculated that these features account for 2,512 lb. of the total weight, which should be deducted when making a comparison. This would make the weight per passenger seat 643.7 lb. for the all-metal car, instead of 683 lb. as shown.

COMPARATIVE TABLE OF CAR DIMENSIONS

	Manchester-Bury M. U. C.	Liverpool-Southport M. U. C.	Long Island Trailer	Manchester-Bury Trailer	Liverpool-Southport Trailer
Length over all	63 ft. 7 in.	60 ft.	62 ft. 9¾ in.	63 ft. 7 in.	63 ft. 7 in.
Width over body	9 ft. 4 in.	10 ft.	9 ft. 9¾ in.	9 ft. 4 in.	10 ft.
Height of car inside, floor to roof	8 ft. 3¼ in.	8 ft. 0½ in.	....	8 ft. 3¼ in.	8 ft. 3¼ in.
Height from rail to top of floor	4 ft. 1¼ in.	4 ft. 4¼ in.	4 ft. 4⅝ in.	4 ft. 1¼ in.	4 ft. 4¼ in.
Height from rail to top of roof	12 ft. 4½ in.	12 ft. 7⅞ in.	13 ft.	12 ft. 4½ in.	12 ft. 7⅞ in.
Center of trucks	45 ft.	40 ft. 6 in.	39 ft. 9 in.	45 ft.	45 ft.
Wheelbase of trucks	9 ft.	8 ft.	6 ft. 4 in.	10 ft.	10 ft.
Type of roof	Clerestory	Clerestory	....	Elliptical	Elliptical
Number of passenger seats	74	68	80	95	97
Weight of two trucks complete	62,719 lb.	53,150 lb.	18,000 lb.	22,456 lb.	22,456 lb.
Weight of car unloaded	120 960 lb.	114,240 lb.	63,100 lb.	64,960 lb.	61,768 lb.
Weight per seat	1,634 lb.	1,680 lb.	788 lb.	683.7 lb.	636.7 lb.

The make-up of the standard train which operates on the multiple unit control system consists of five cars, the leading, center and rear cars being third-class motor cars and the intermediate vehicles first and third-class trailer cars.

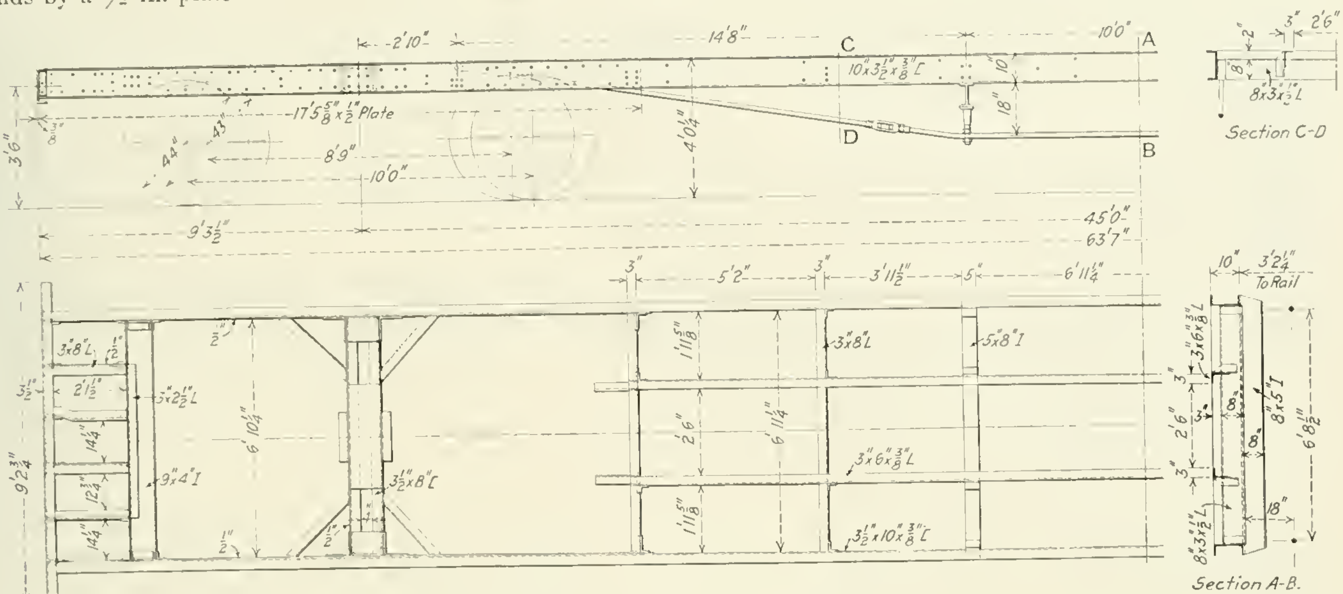


Floor Plans of the Motor Car and First and Third Class Trailers

Underframes

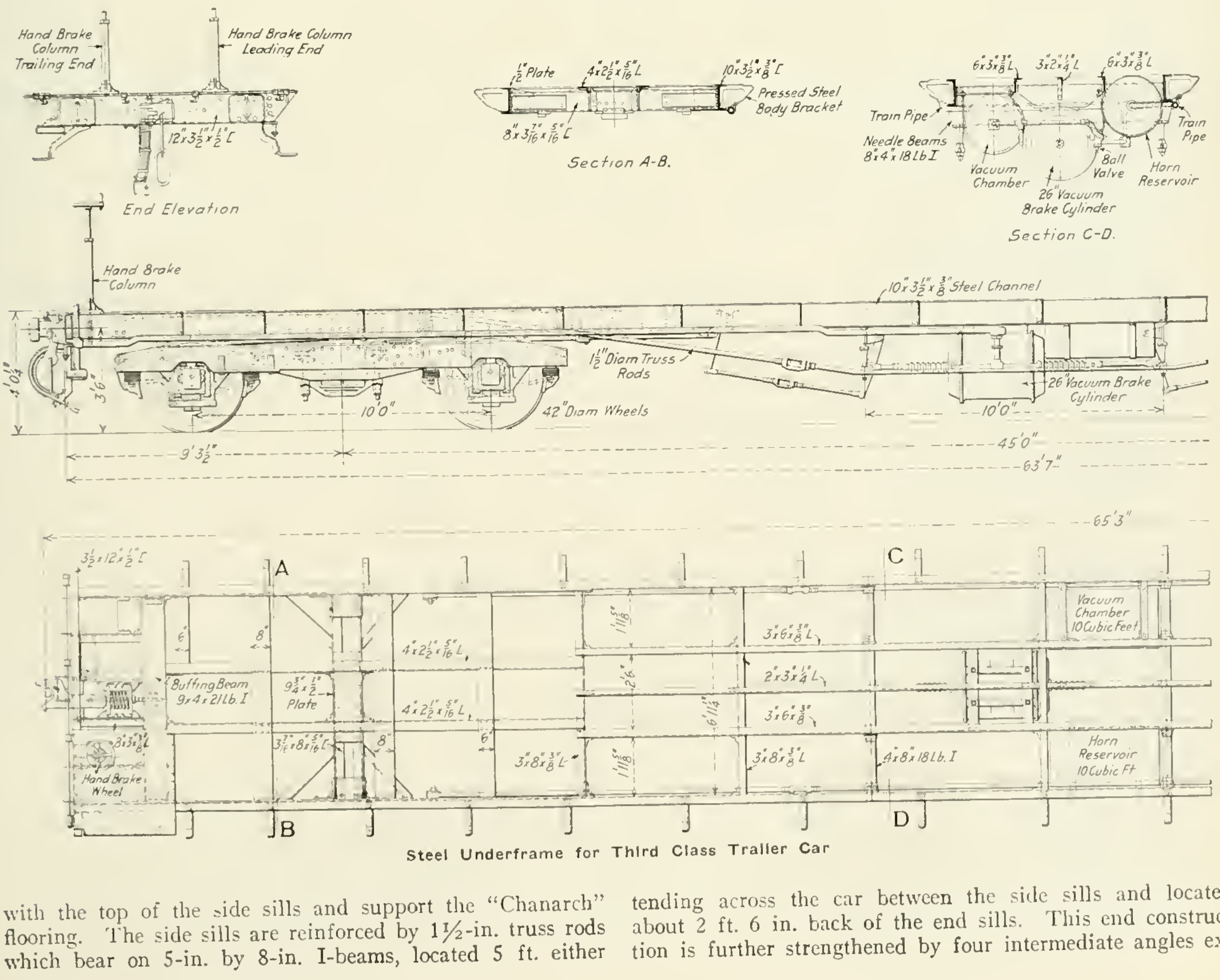
The underframe for the three types of cars, that is, the motor, the first and third-class cars, are substantially the same, having a length over end sills of 36 ft. 7 in. The

side sills are made up of 3½-in. by 10-in. by ⅜-in. channels. The side sills, however, are further reinforced at the ends by a ½-in. plate riveted to the side sill, which extends



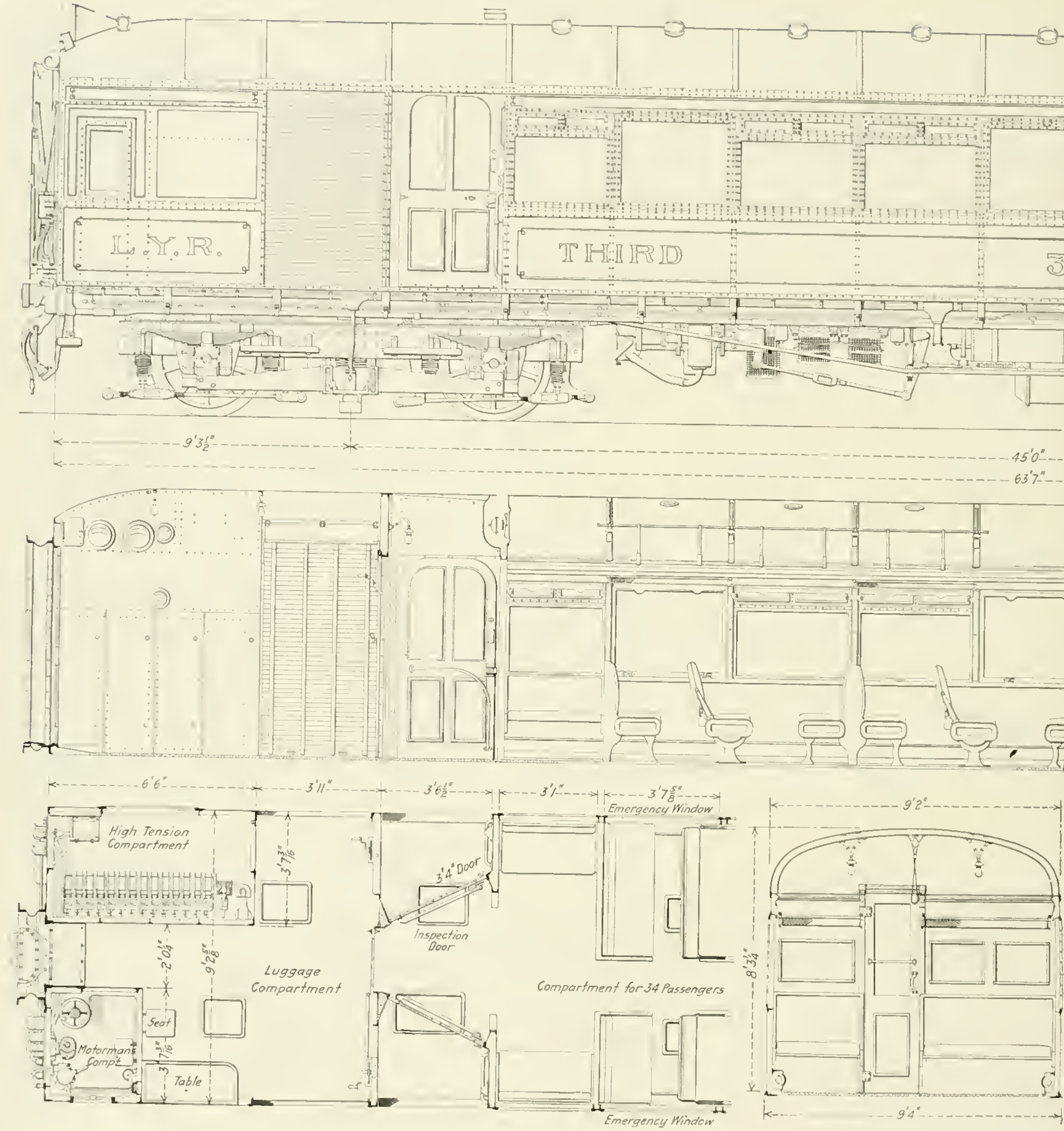
Steel Underframe for the Motor Cars

17 ft. 5⅝ in. back of the end sill. The crossbearers are 3-in. by 8-in. alloy steel angles, and the intermediate floor sills are 3-in. by 6-in. by ⅜-in. angles. These are set flush

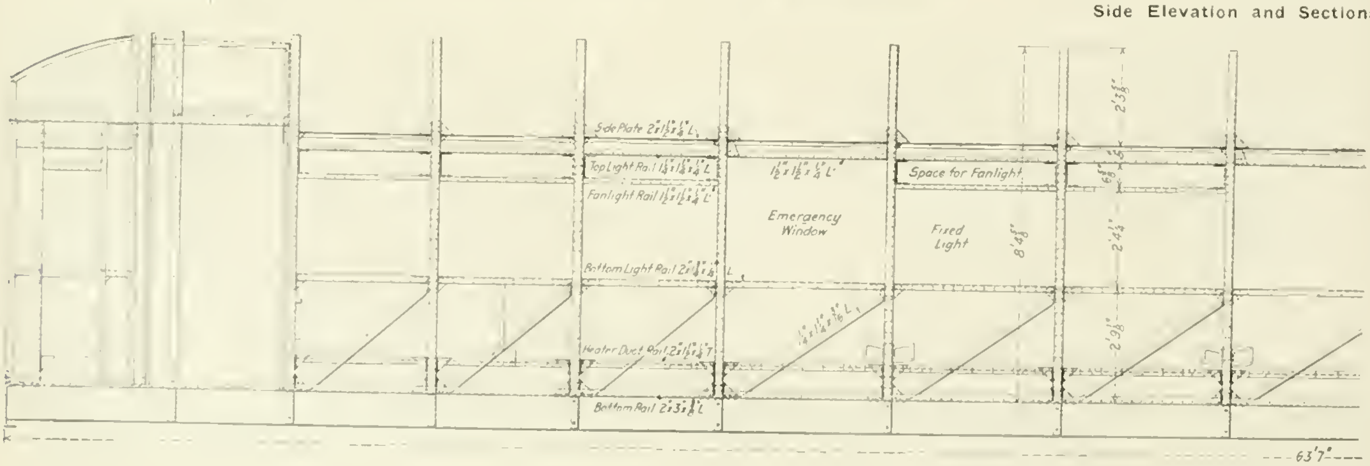


Steel Underframe for Third Class Trailer Car

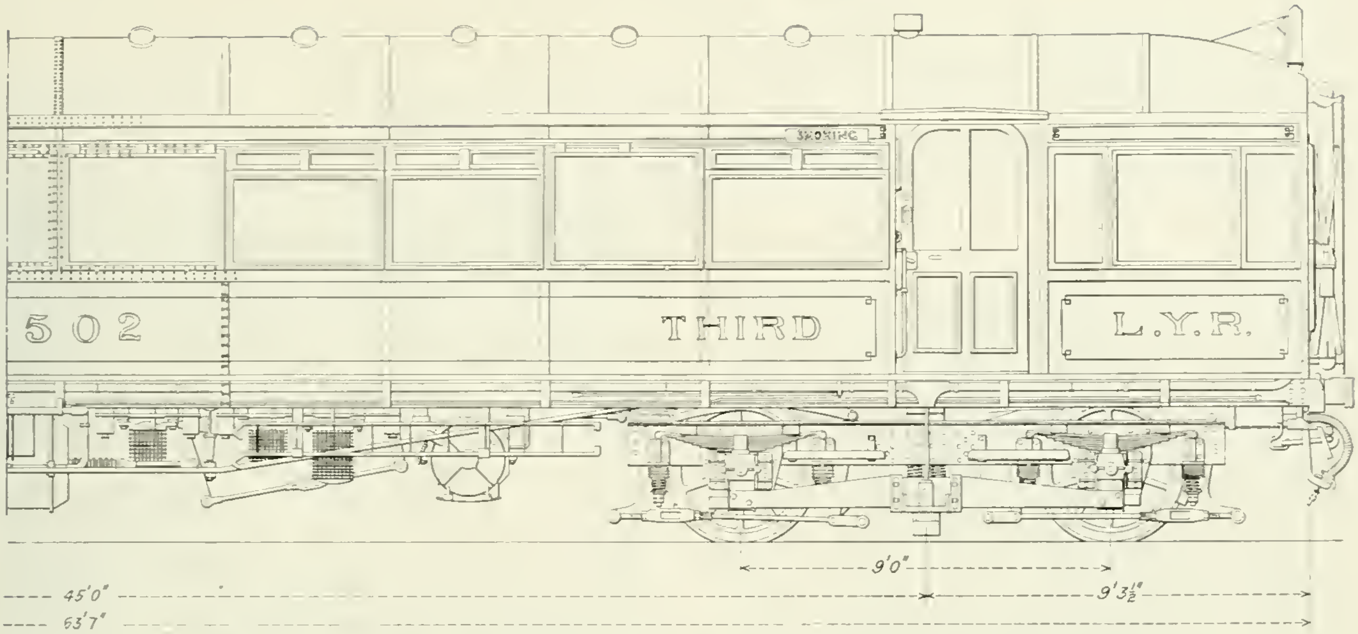
with the top of the side sills and support the "Chanarch" flooring. The side sills are reinforced by 1½-in. truss rods which bear on 5-in. by 8-in. I-beams, located 5 ft. either side of the center of the car. The end sills are 10-in. by 3½-in. channels. The body bolsters are built up of four 3½-in. by 8-in. angles, with ½-in. side plates and cover plates. They are attached to the side sills by steel pressings, and are further reinforced by pressed steel gusset plates. The draft gear is anchored in a 9-in. by 4-in. I-beam extending across the car between the side sills and located about 2 ft. 6 in. back of the end sills. This end construction is further strengthened by four intermediate angles ex-

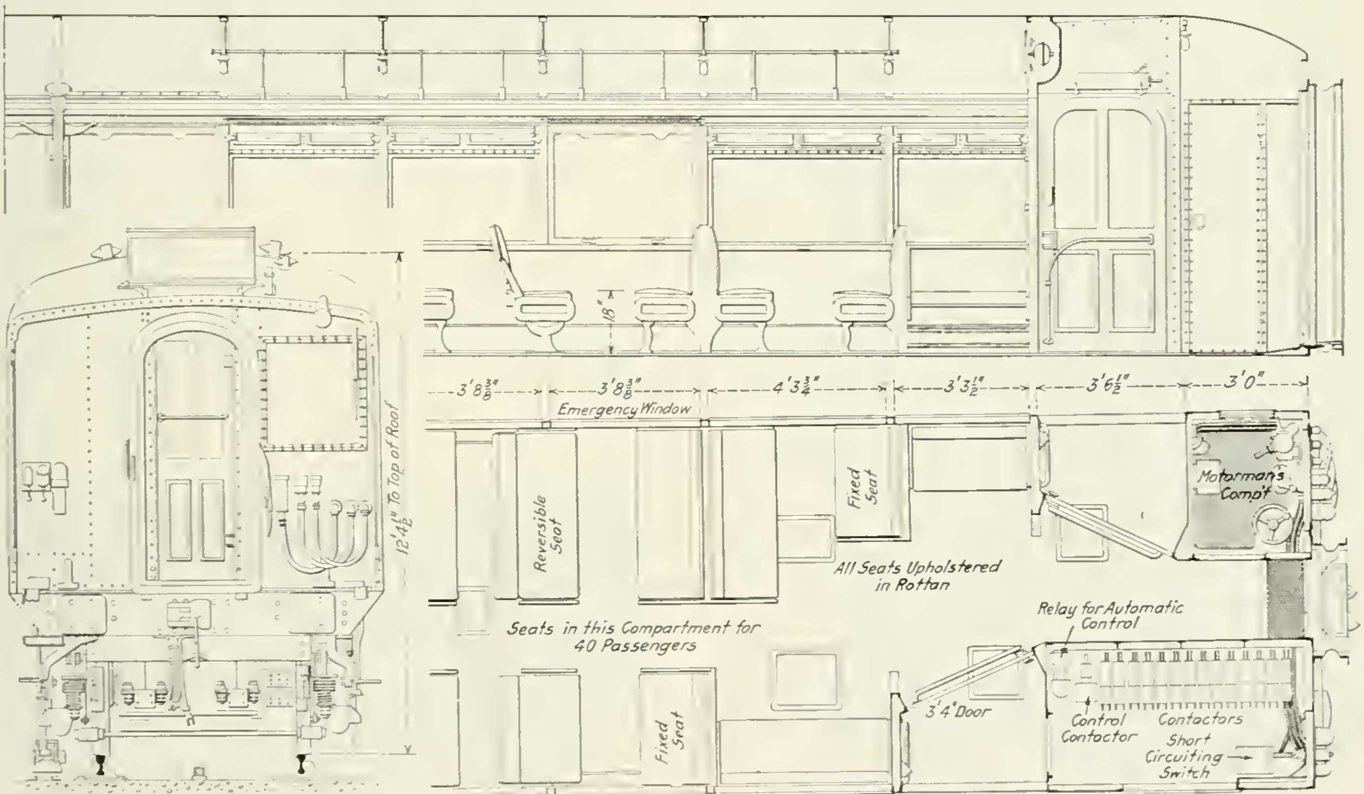


Side Elevation and Sections



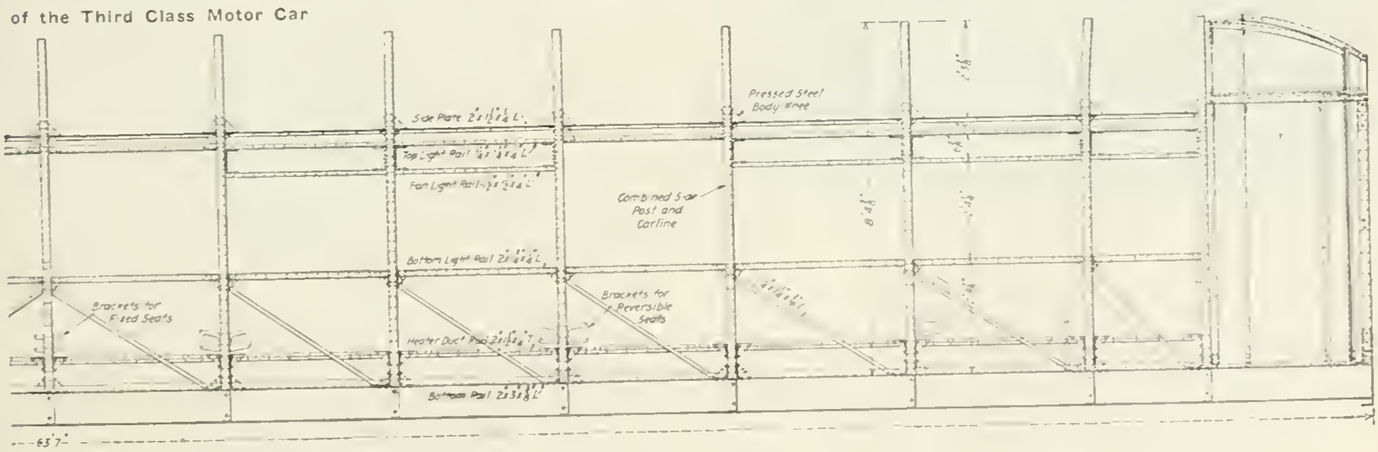
Side Framing for





End View.

of the Third Class Motor Car

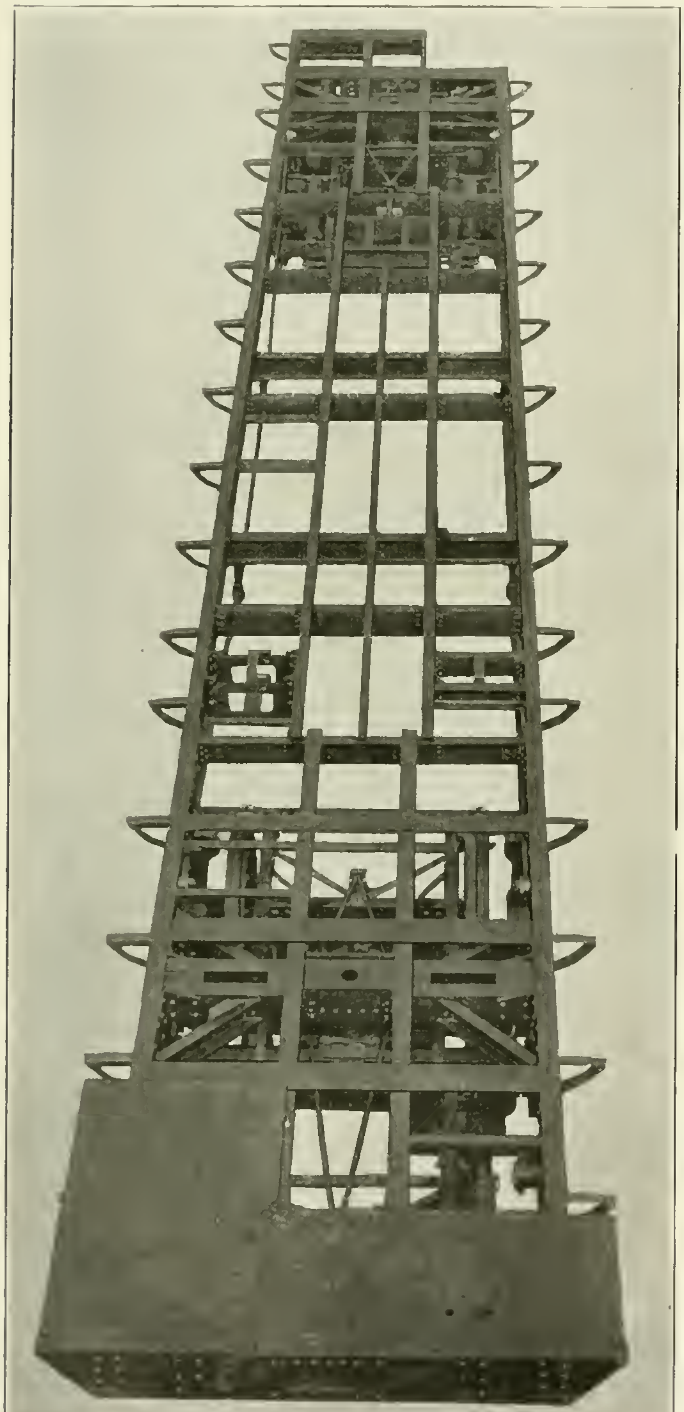


Third Class Trailer Car

tending between the end sill and the I-beam, two of which are 3-in. by 3-in. and the other two 3-in. by 8-in. by 3/8-in. alloy steel angles. All of these angles have a side plate of 1/2-in. material.

The intermediate sills and crossbearers on the motor car are cut short just over the trucks in order to provide proper space for the motors.

The underframe for the first and third-class trailer cars



Trailer Car Underframe

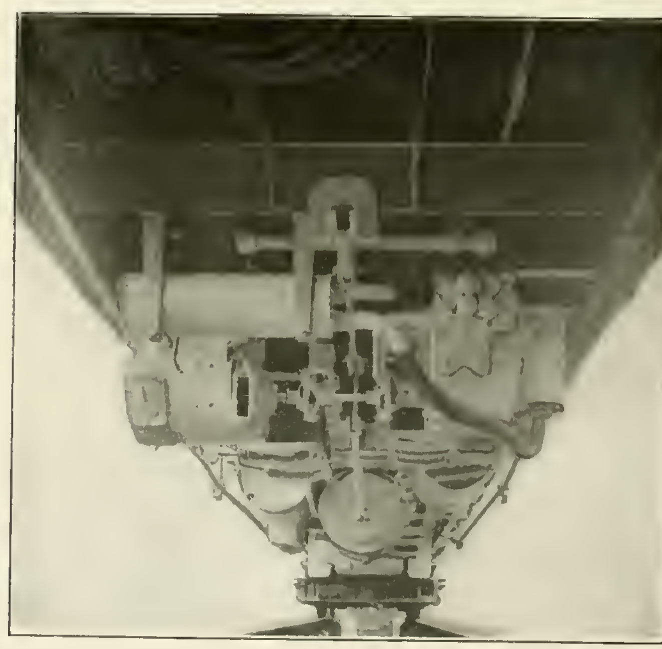
are practically the same and are only different from the underframe of the motor car in that they have an additional intermediate sill made up of a 2-in. by 3-in. by 1/4-in. angles. They are also further strengthened over the trucks by cover plate strips and by two intermediate sills made up of 4-in. by 2 1/2-in. by 5/16-in. angles.

Superstructure

The superstructure is designed to carry part of the load and acts as a continuous side girder to the underframe. It is made up of a bottom side 2-in. by 3-in. by 3/8-in. angle, which is riveted to pressed steel brackets extending out from

Interior View of Motor Car During Construction

the side sill of the underframe to which they are riveted. The side posts and carlines extend in one piece from the side sill to the ridge pole. They are 2 1/2-in. by 1 3/4-in. alloy-steel channels being bent and riveted to the side sill brackets at the bottom and united at the top by a plate riveted to the webs of the channel. They are equally spaced throughout the center of the car on 3-ft. 10 7/8-in. centers. At the ends the spacing is a little closer together. They are braced by a belt rail of 2-in. by 1 3/4-in. by 1/4-in. angles, located approximately 2 ft. 8 in. above the lower angle; by an upper



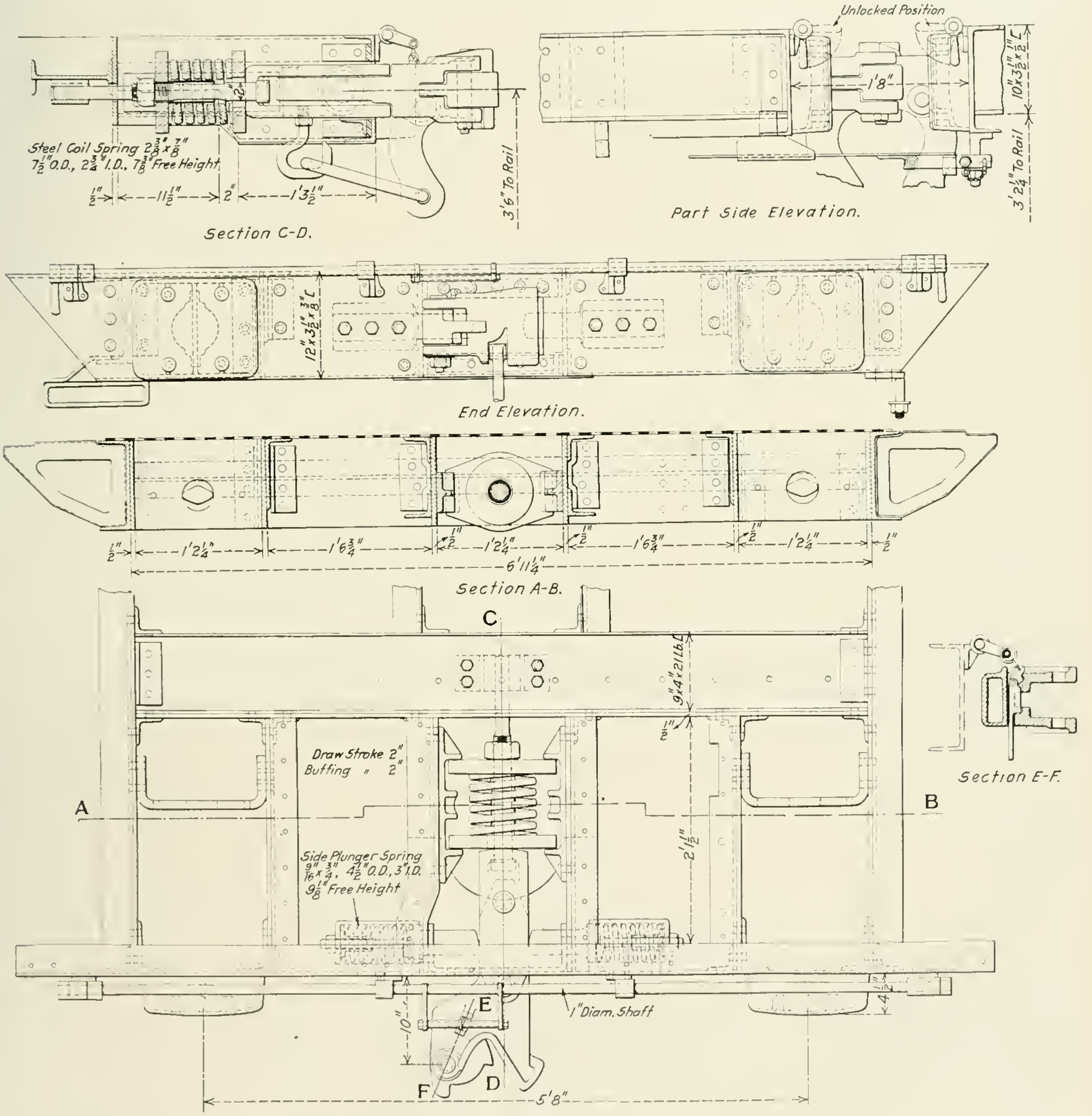
Equipment Beneath the Car Underframe

belt rail of 1 1/4-in. by 1 1/4-in. by 1/4-in. angle, and a side plate or cant rail of 2-in. by 1 1/2-in. by 1/4-in. angle. In addition to this there are diagonal braces of 1 1/4-in. by 1 1/4-in. by 3/16-in. angles extending from the juncture of

the lower belt rail with the side posts to the 2-in. by 3-in. by 3/8-in. angle bottom side rails.

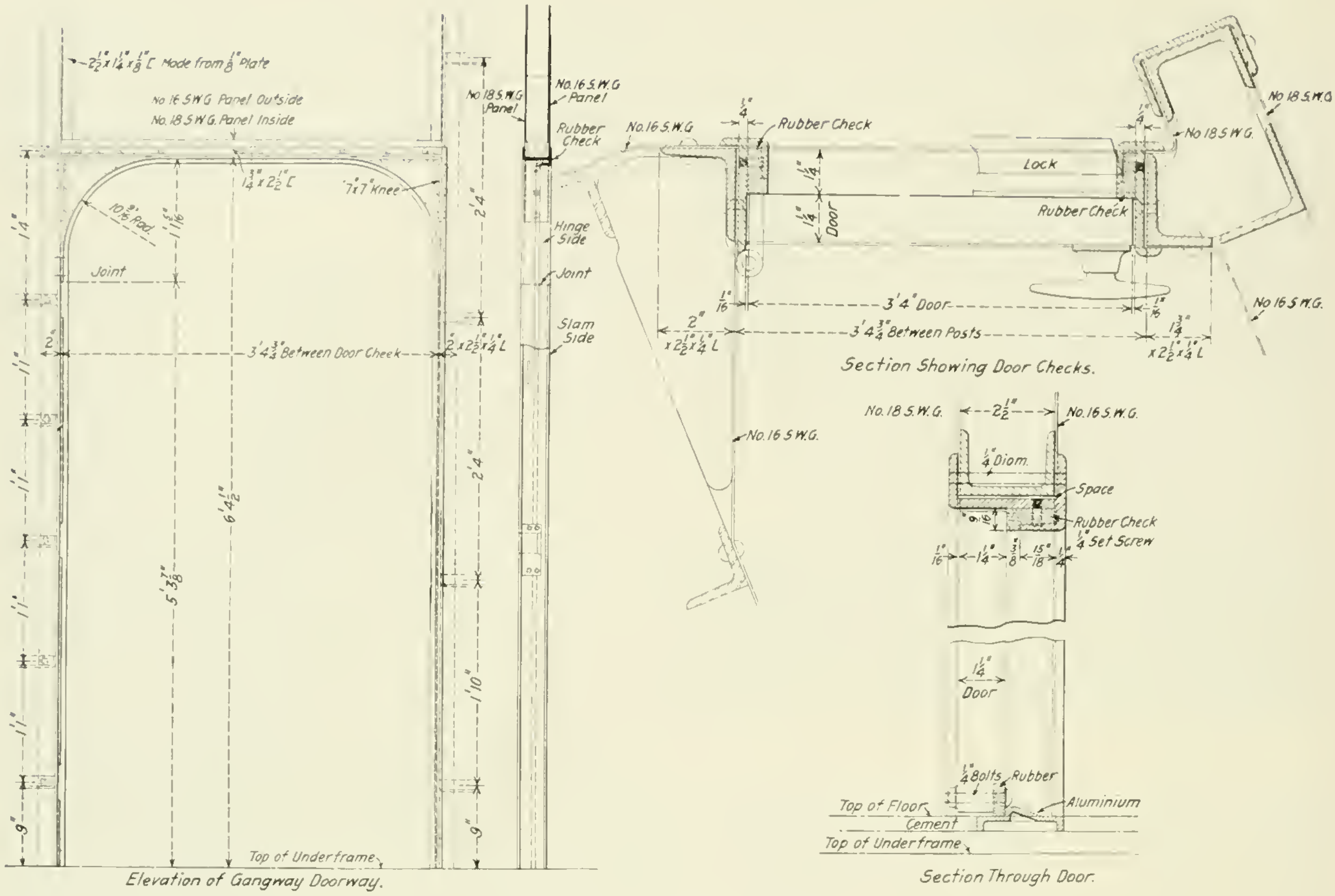
All the longitudinal rails are connected to the side posts by pressed steel knee plates. In addition to these longitudinal rails there extends along the lower part of the body structure a heater duct rail of 2-in. by 1½-in. by ¼ in. tee. There are other longitudinal rails extending between the side posts, which give the structure additional strength. The side and roof plates are of aluminum. The roof sheets are made up of aluminum plates 12 ft. by 4 ft. 6¼ in. by No. 14 S. W. G. They are carried in one piece from side to side and are joined to the carlines with 2-in. by 1-in. strips of aluminum, which are well lagged and which are double riveted with ¼-in. aluminum rivets spaced at a 3-in. pitch. In as much as the climate in which these cars are to be run is neither excessively cold nor excessively hot, it was unnecessary to insulate the roof, and as the appearances do not require it no inner roof was used.

The sides of the cars below the windows are sheathed with No. 14 S. W. G. outside aluminum plates and No. 18 S. W. G. inside aluminum plates, with an air space of 1¾ in. between them. The inner sheathing was to improve the appearance of the car and also to serve as insulation. The side window frames are of aluminum and are riveted to the side posts and rails with ¼-in. aluminum rivets. The glass is embedded in felt and secured by a wrought iron frame secured to the main window frame.

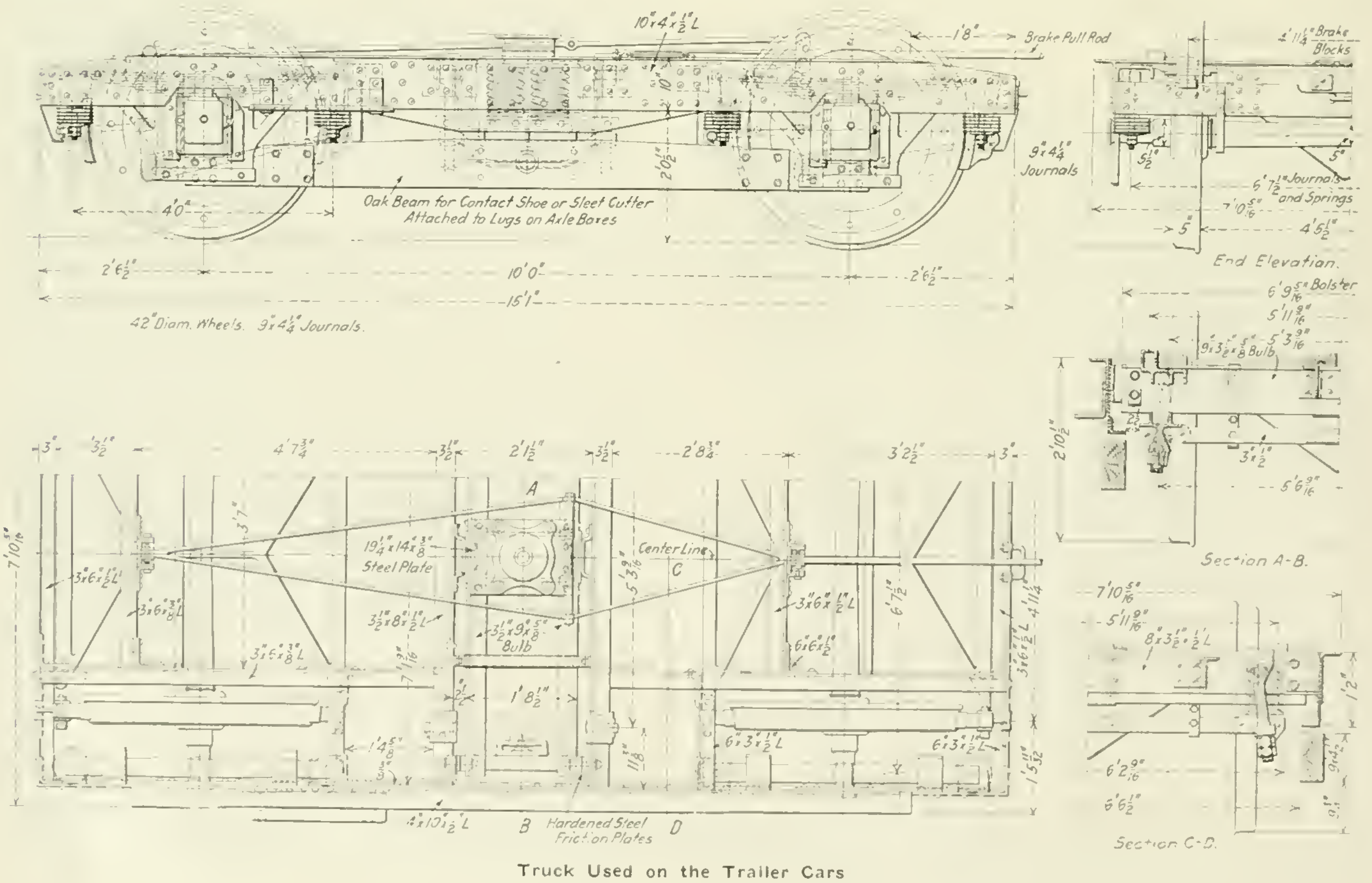


Arrangement of Automatic Coupler and Draft Gear

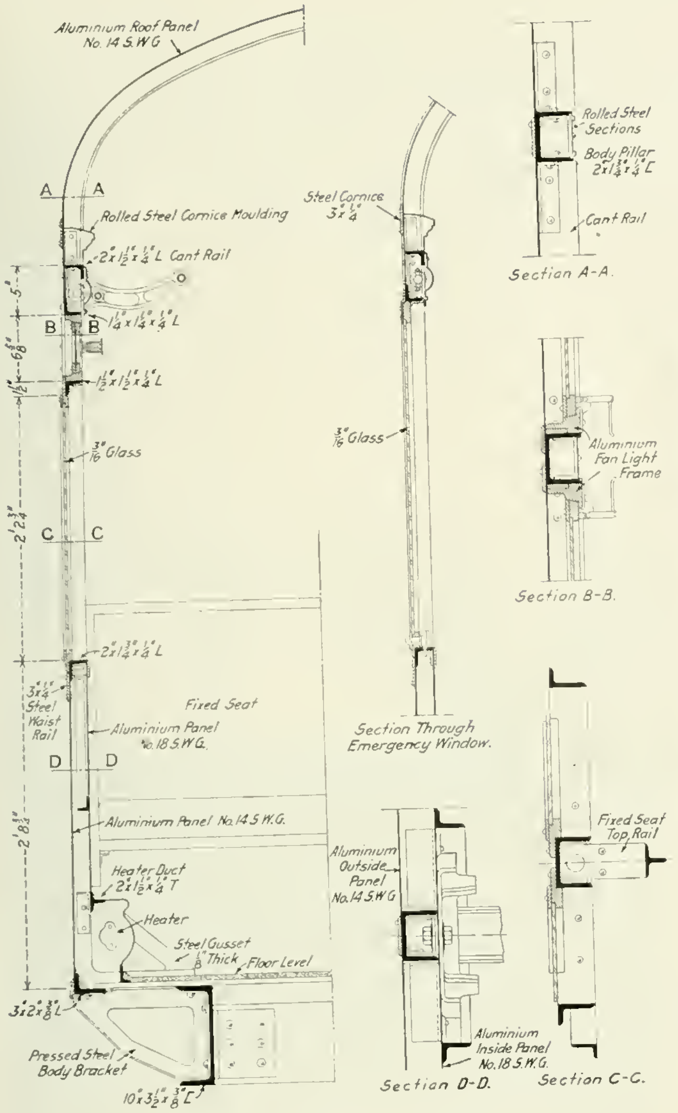
As will be seen from the drawings showing the seating arrangements, some of the seats of the third-class cars are placed back to back. The outside ends of both the fixed and the reversible seats are supported on brackets riveted to the side posts.



Arrangement of Gangway Doorway



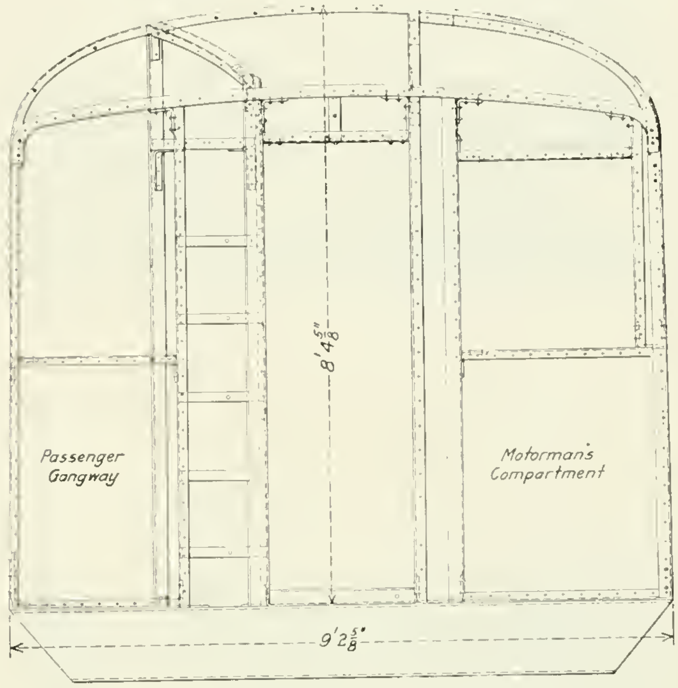
Truck Used on the Trailer Cars



Section Through Body Structure

Doors

The arrangement of the doors is rather unique. In keeping with the all-metal construction of the car, these doors are of steel, having been furnished by Heywood Bros. & Wakefield Co. (United States). They are hinged on the inner door posts and arranged to swing outward, which greatly expedites the unloading of the cars. They are fitted

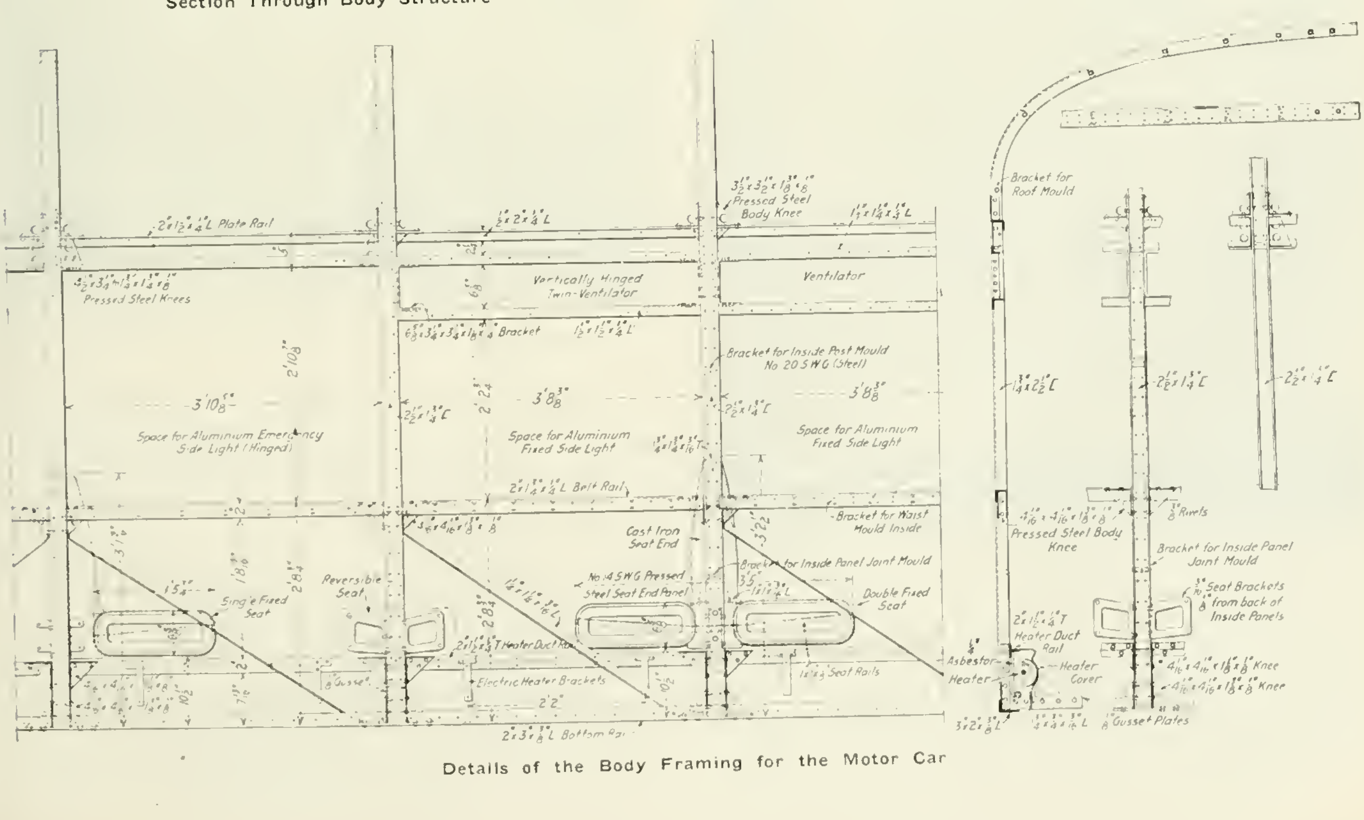


End Elevation of the Third Class Trailer Car

with an india-rubber welt in the door check to provide a water-tight joint and to eliminate any metallic sound when the door is closed. They weigh 141 lb. each, as compared to 114 lb. for oak doors.

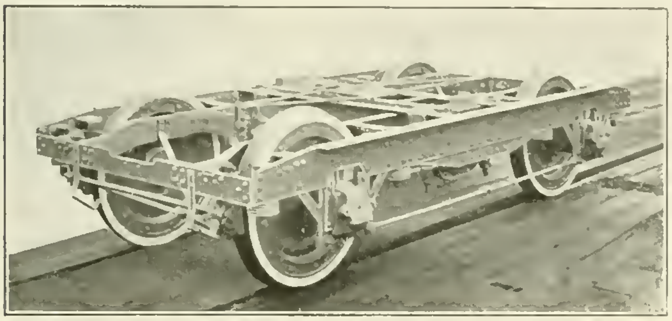
Trucks

The trucks for the motor and trailer cars are of similar construction, those for the motor cars being built of heavier



Details of the Body Framing for the Motor Car

materials. Both are built up of structural steel, with box girder bolsters having a lateral swing of 1½ in. in each direction. Four helical bolster springs are used, and semi-elliptical springs are used over each pedestal. The body framing of the motor truck is made up of 12-in. by 4-in. by ½-in. angles, being provided with heavy gusset plates



Trailer Car Truck

at the top. The truck bolsters are made up of 8-in. by 3-in. by 1½-in. angles.

The trucks for the trailer cars have a body frame made up of 4-in. by 10-in. by ½-in. side angles and 3-in. by 6-in. by ½-in. end angles. The truck bolsters are built up of 9-in. by 3½-in. by ⅝-in. bulb angles, with 8-in. by

Rear End of Car, Showing Damage to Door in Collision

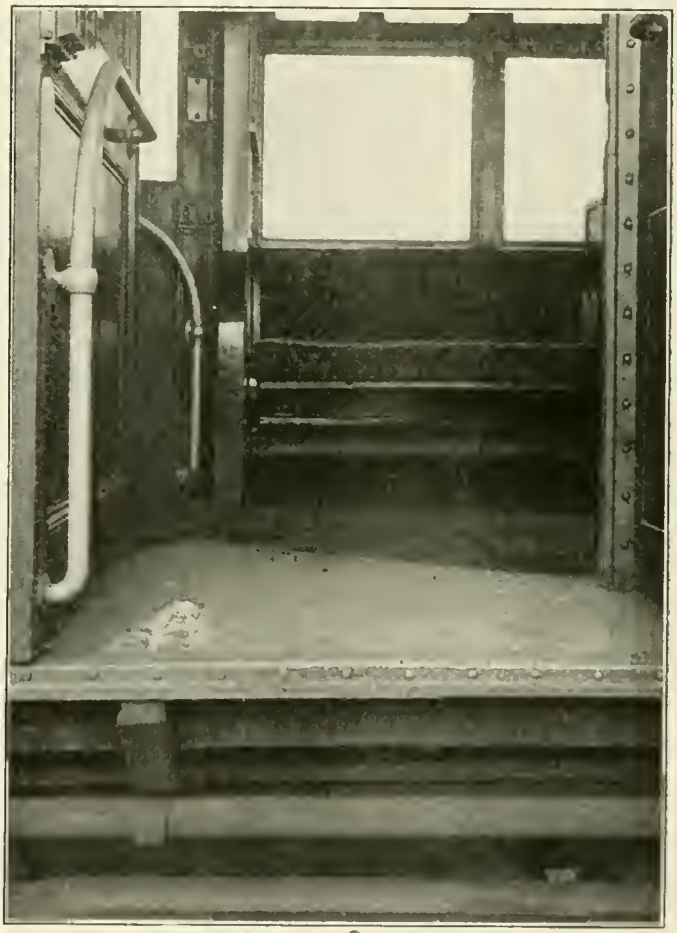
3½-in. by ½-in. angles for the transoms. The side bearers are located 5 ft. 11 9/16 in. between centers.

The motor trucks have a wheel base of 9 ft., which gives ample room for the two 200 hp. motors. The trailer trucks have a wheel base of 10 ft. In both cases the diameter of the wheels is 42 in. and the journals are 9 in. by 4¼ in. for the trailer trucks and 10 in. by 5 in. for the motor trucks. The driving gears for the motor trucks are pressed on to the axle, and in addition are bolted to the truck wheels in order to relieve the axle of severe torsional strains.

A gearing ratio of 2.36 to 1 is provided. The clasp type of brake is used on both trucks. The brake shoe is solid and of sufficient hardness to give a mileage of 8,000 miles.

Maintenance

In a paper before the Institute of Civil Engineers a short time ago both George Hughes, chief mechanical engineer, and F. E. Gobey, assistant carriage and wagon superintendent of the Lancashire & Yorkshire, discussed the question of maintenance of these cars. There have been in service for three years 46 of these all-metal cars. They have averaged 250,000 miles per annum and have operated in temperatures varying between 20 deg. F. and 120 deg. F. There has been no weakening since they were first placed into service



Showing Damage to Gangway in Collision

in any respect. The flooring composition has had no effect whatever on the floor sheets, but the original ⅜-in. thickness upon the top of the sheets is slightly worn in the aisles. It was found that aluminum oxidizes in contact with "Flexolith," and in this case aluminum has been replaced with brass.

The removal of the inside panels does not show that any corrosion or sweating has taken place on either body, framing or the inside of the outer panels. The actual car repairs in traffic have been slightly less than for wooden cars during a similar period. The all-metal cars are overhauled every two years, and it is expected that less material and labor will be required on them than for wooden cars.

The motors are given a general overhauling every six months, when the car body is removed from the motor trucks,

the motors taken out, the armature removed, the commutators examined, turned up and the mica undercut if necessary, the brush-gear overhauled, the armature windings cleaned, blown out and varnished, the field frame cleaned and connections examined, the motor trucks inspected, the wheels turned up if required and the bearings adjusted. Every 12 months the electrical equipment is overhauled. The average total number of faults per month for the 12 months ending July 31, 1918, was 72.4 and the faults per thousand motor-car miles was 0.78, of which the control equipment was responsible for 0.4 and the motor, motor trucks, cars and subsidiary equipment was responsible for 0.38, the largest of which was 0.13 for the subsidiary equipment. The reasons for the defects of the control equipment being so high was on account of the automatic control, which very largely increases the number of small parts.

In comparing the performance of the new all-metal cars with the cars of composite construction used on the Liverpool-Southport line, it is found that the faults per 1,000 motor-car miles was practically the same, being 0.76 on the Liverpool-Southport line as against 0.78 on the Manchester-Bury line. The greatest trouble in the Liverpool-Southport line was given by the motors, which average 0.26 faults per thousand motor-car miles.

The performance of the all-metal cars in collision has been demonstrated by three collisions that have taken place, in which it was found that the damage to the all-metal cars was confined to the ends of the cars. The doorways are the principal buckling points, which, being at the extreme ends of the cars and having vestibules, absorb the blow. The light car structures minimize the force of impact, and the effects of the collision where the metal framing is suitably disposed. There was no difficulty in carrying out the repairs in the car shops. The metal structure absorbs collision shocks in less space than the wooden cars, with the resultant effect that there is less liability of injury to passengers. Some illustrations are included to show the effect of collisions on these all-metal cars.

The Inspection of Freight Equipment

The Defects that must be Avoided in the Selection of Freight Cars for Certain Commodities

BY L. K. SILLCOX
Master Car Builder, Chicago, Milwaukee & St. Paul

In any successful movement of traffic it is of prime necessity to first see that cars going to industries, loading stations or loading territories beyond the reach of local car repair points are gone over and put in suitable condition to run to whatever destination they may be scheduled to reach; also that they are in fit shape to carry the lading which they are intended to carry, this to avoid delay in movement, damage claims or the necessity of transferring the load en route. For this reason large terminal loading tracks should be piped with air and have suitable repair materials and facilities conveniently placed. In the past entirely too little attention has been given equipment at loading platforms at large industries, when it has been a matter of daily experience to have cars brought right over at the close of the day and placed in our most important time freight trains, and then there was not time enough allowed to do the necessary work on the equipment, the latter being true since no effort had been made to put the cars in shape while they stood idle during the day. The result is obvious, and with the matter brought out so clearly and being one of daily observation we must make the necessary effort locally at every station on the system to correct this state of affairs at once. No one could possibly estimate the great and tremendously far-reaching effect of this and what good may result when this item is properly understood and uniformly applied.

A box car to handle grain, flour, sugar or groceries should be in the best condition possible. The siding must be tight, the roof non-leaking and the floor and lining level and smooth, so as not to chafe or injure the contents. Wool, raw cotton, hay, brick, etc., may be handled in a car in fair condition without damage. A leaky roof or open siding will not injure these articles, and they cannot fall through cracks in the floor as would bulk grain. The only essential for cars handling the last mentioned articles is that the frame work of the car be strong enough to hold the load and that the trucks and draft gear be in good condition.

A refrigerator car must always be in good condition in order to protect its lading, due to the fact that the requirements of this service are very rigid. A stock car should be in good condition in order to handle live stock without damage, but the same car in fair condition will haul barreled goods, rough lumber, ties, lump coal and many other articles very satisfactorily. A gondola must be in very good condition to hold slack coal without loss, but will hold lump coal, coke, scrap iron, etc., if in only fair condition. Trouble is experienced when we get out into the lignite coal district. If any old car is used for this coal loading, the car and contents are both liable to be burned up. A pretty good car must be used on account of the fire risk.

There are a good many commodities that should never be loaded in a first-class car, and this is one of the worst practices that is prevalent on railroads today—the abuse of good cars by loading certain commodities in them. For instance, hides, fertilizers, immigrant outfits, scrap iron, coal, pitch, oil, refuse from sugar factories, tar and things of that kind should never be put in a first-class car. This matter should receive more attention than it does at present. If we have around 75 per cent, or about three-quarters of the box cars in first-class condition we ought to be able to take care of our business in a satisfactory manner. By first-class condition is meant a car that is good enough to handle grain or similar products.

In order to define the requirements of cars for various commodity loading the following will govern:

Grain Cars

A suitable car for bulk grain loading is one that has the decking, lining, sheathing, posts and grain strips and roof in a good, tight condition, or in other words, *will not leak grain*, or a car which can be made fit by the shipper at the time and place of loading by ordinary and proper care in the use of coopering material and by a reasonable amount of cleaning. A car with doorposts shattered or broken or loose from the framing, or with other defects of such character as to render the car obviously unfit, or with the inside showing the presence of oil, creosote, fertilizer, manure or other damaging substance of like or kindred character should not be used for grain. Where a shortage of suitable cars ob-

Continued from the January issue.

tains, it is often desirable and necessary to fit cars up especially, and under these circumstances, where the body of the equipment can be made fit and suitable in 20 carman-hours or less, it should be done. This work is usually carried out under extreme pressure and may consist of employing anchor bolts to secure door posts, slabbing the sheathing at both the end and sides to sills, reinforcing broken posts with old iron, such as levers, threshold plates, iron scraps and applying a supplementary end lining over the old or defective structure, including false bulkheads in the body of cars, jacking bulged out ends in place and applying straps, anchor rods or bars, slabbing side or end plates, slabbing belt rails, patching sheathing, roofing and floors with old metal roofing. Under all circumstances the running gear, brakes, wheels, lubrication and safety appliances must be in as nearly 100 per cent condition as possible. All of the above is exclusive of applying grain doors, as these are installed by the shipper. In delivering empty cars suitable for grain loading to our connections, it shall be the understanding that the cars which cannot be made fit with the expenditure of ten carman-hours shall be returned, the same to be true as a basis of acceptance between connecting lines giving us care for such loading and ourselves. In further explanation, box cars which are fit, or such as have light running defects, will be accepted or offered on an equal basis. In order that there may be a universal understanding as to what is meant by the term "light running repairs," it will be understood that this covers cars having such defects as missing plain wooden side doors (this not to include Wagner or other special all-metal or steel-bound side doors), broken draft timber or strap bolts, slight defects to wooden or metal roofs, to side or end sheathing and lining, or other light running repairs such as can be made by the receiving line on division or yard repair tracks within the time allowance prescribed, or such as can be coopered by the loader to make the body fit for the lading intended.

Flour Cars

In going over cars for flour loading, the main points to be considered are a good, tight roof and sides, good, close-fitting doors, a good, clean floor and freedom from the presence of oil, creosote, fertilizers, manure or acid spots which are liable to contaminate the lading. Roofs to be given water test where possible. A car that has been loaded with hides should not be used for flour, or any other car that has been loaded with commodities which have left a bad odor. During the winter months cars equipped with all-metal roofs or ends uninsulated should not be selected for flour loading unless it is distinctly understood that the doors will be left open at least four hours after being loaded, as when hot flour is put into a cold car that has an all-metal roof or end exposed in the interior it causes the metal to sweat, and the moisture dropping down on the sacks injures the flour.

REPAIRING FOREIGN CARS

In handling repairs to foreign cars which are in need of heavy work, either on account of deterioration, damage or wreck, the following should be remembered:

It is necessary that division terminal stations which are equipped with planing mills, compressed air facilities and steel working tools, give attention to the classified repairs on foreign cars which are of such construction, so that when repaired and put in first-class shape they will be available to our service. Under these circumstances cars with steel underframe, steel center sill or steel draft arms (arms to extend at least 30-in. behind bolster) should be selected in the order named and box cars should be given preference over other types.

We should aim to do the best possible work on foreign cars coming to our repair tracks and turn them out in fit condition to properly meet traffic and commodity requirements. For instance, when a foreign car comes in for attention to the draft sills or steel underframe, if in such condition as to require also new sheathing, roof, floor or lining, end or posts, doors, bolster, or draft gear, etc., and suitable material is in stock the car should be put in first-class shape. The main shops at Milwaukee, Dubuque, Minneapolis, Green Bay and Tacoma are doing this now. This plan must be strictly observed in order that we may be in a position to bill against foreign lines to an equal or greater amount than they are billing us for repairs to our cars on their lines.

It was mentioned in the paragraph just preceding that steel underframe equipment or cars of like construction should be selected, the reasons being obvious. On the other hand, cars more than fifteen years old, which are of weak construction, generally equipped with short wooden draft timbers, and which appear to be in an unsafe condition to run and if rebuilt would probably not stand up under present service conditions, are to be set aside, written up on form CD-27 for disposition and this office will in turn take the matter up with the car owners to secure authority to strengthen and rebuild, dismantle or send home empty. Every effort must be made to keep such cars off the railroad and where found empty in this condition they should be held so as not to cause damage and difficulty to other good cars in service, also where coming to repair tracks under load they should be transferred and reported as above, unless we have a near connection with the car owner.

Precautions should be taken not to spend more than $250 on any foreign car of 40 tons capacity or over and which is less than 12 years old. Roughly speaking, this expense will permit the application of an entire new roof, two side doors and light repairs to the draft gear, couplers, boxes, wheels, etc. It is not intended to apply a whole new superstructure or underframe, without obtaining the appraised value of the car from the owner and determining whether we can settle for less expense than the authorized repairs.

Cars of 30 tons capacity and equipment more than 12 years and not over 18 years old should be limited to $100, which will allow for the application of an entire roof, or two ends, or flooring and doors, or new sheathing, or two longitudinal sills, draft sills and end sill, but as already stated only such cars which are equipped with steel underframe, steel center sills or steel draft arms extending back of body bolsters should be extensively repaired. Cars not coming under the above classes should be held for disposition.

Cars must be written up promptly on form CD-27 and when the report is received in this office we will send a copy of form CD-27 to the owner. If a reply is not obtained from the car owner within 30 days, we will take the matter up with our executive officer who will get in touch with the car owner's executive for immediate response; the same is true of material required from owners to make repairs to their cars. It is not intended to hold cars more than 30 days and the foreman should keep after the master car builder continually if instructions for disposition are not received promptly. Billing must be kept up to date and properly checked at all times.

General Conditions Governing the Repainting of Foreign and System Freight Cars

The preservation of freight car equipment of all railroads will be maintained by the necessary repairing and restenciling. When paint on freight equipment has perished to the extent of permitting the steel to rust and deteriorate or the wood to become exposed to the weather, the car should be repainted. The body (including the roof) should be entirely repainted if for any reason it is found necessary to re-

paint one-third or more of the car. Before applying paint to steel or wood it should be scraped so as to clean off all blisters and loose paint, also removing protruding nails and tacks.

When repainting freight equipment cars, two coats will be applied to all new parts and old parts of the body which have been reworked causing removal of the paint. One coat will be applied to parts where the old paint is in good condition. Should the old paint be found in such condition as to require two coats, they may be applied.

The station marking showing where the car was last weighed should not be changed unless the car is reweighed. The stenciled letters and numbers on all freight equipment cars will be maintained and the identity kept bright. When the lettering or numbering is found in bad condition, the identifying marks should be renewed either by repainting the car or by applying new stenciled letters and numbers. In selecting cars for this purpose, preference should be given those on which the marking and painting is in the poorest condition. Do not cut stencils for special marking such as the monogram on Great Northern, Santa Fe or Southern Pacific cars.

If there is not sufficient paint on the car properly to retain the new stenciling and the condition of the car does not justify entire repainting, one coat should be applied as a panel back of the stenciling so that the paint used in applying the numbers and letters will hold, otherwise the marking applied will soon become illegible, making it necessary to again apply the identity marking within a short period. Detention of equipment from service for painting should be avoided, when possible. A great deal of this work can be done to open cars in transportation yards when under load in storage.

These instructions apply equally to foreign and system cars and all should be repainted in accordance with the above instructions when on repair tracks, regardless of ownership. Charges for repainting and restenciling are to be made in accordance with the A. R. A. rules.

Date and Year Built

The A. R. A. rules provide that after September 1, 1919, cars will not be accepted in interchange unless stenciled showing the month and year built, or bearing a badge plate giving this information. Cars built prior to 1895 may be stenciled "Built prior to 1895" or bear a badge giving this information. In the case of tank cars, the body and tank should bear distinctive dates unless constructed at the same time.

Repairing Cars at Loading Tracks

At many terminals there is a loading or transfer track where cars are lined up and are not switched for almost 24 hours. At places where these conditions exist every effort must be made to have the proper number of men assigned to inspect and to repair all possible defects on these cars. There is much work that could be done even to the extent of caring for the air brakes. Brakes that are out of date could be cleaned and after they are cleaned the aid of a switch engine could probably be gotten to assist in testing the work at its completion. At this time the piston travel could be checked and the hose tested for porosity. All work done on cars at these loading points relieves the outside yard of just so much work, and inasmuch as it is much safer working on a car where there is no switching, as stated before, the efforts of all should be concentrated on this feature.

Repair Parts and Tools

Inspectors must keep constantly on hand for repairs a supply of all parts of the equipment that are liable to get out of order and which can be replaced while the car is in the yard. However, unless the proper tools and appliances are at hand, nothing will be accomplished, therefore, inspectors should see that they are furnished with the necessary tools. Air brake inspectors should have with them at all times a pipe wrench, for use on the train line and retainer pipe, an S-wrench of the proper size to tighten up the pipe clamps, a coupling groove cleaning tool, which should always be used when renewing gaskets, a cotter key and lever pin drift, and a supply of cotter keys and nuts of different sizes. There should be no excuse for failing to have the necessary repair parts and tools with which to apply them with, because inspectors and repair men would be of little use if they were not able to repair defects which they find.

Old Date Air

All cars marked for bad order triple valves or brake cylinders, as where the brakes either will not apply or leak off quickly, should be treated the same as cars with the brakes out of date (system cars 9 months, foreign cars 12 months). On repair tracks all cars with the aforementioned defects must be repaired but in yards a certain amount of discretion will have to be used. Cars loaded with manifest freight which cannot be held a sufficient length of time to make the necessary repairs, will have to be allowed to proceed, but the car must be properly carded and when its destination is a terminal, must be marked bad order when empty, stating the reason. Empty cars which are to be assigned to shippers to be loaded on our lines must positively have the brakes cared for before being allowed to proceed.

Damage and Loss

Damage or loss to any car, due to wreck, derailment, cornering, sideswiping, flood, overloading, explosion, collapsing structures, or unconcealed fire damage, including cars on ferries or floats; also damage due to storms where the car is derailed or destroyed is chargeable to the railroad holding the car in its possession at the time. Defect cards are not required for any damage so slight that no repairs are necesary, nor for raked or cornered sheathing, roofing, facia, or bent or cornered end sill, not requiring the shopping of the car, the receiving line to be the judge. In case of interior fire damage, in any class of car, if evidence of such internal damage was not discernible externally, it is considered an owner's defect. When flooring planks are out and can be seen from the outside of the car, they are cardable defects. When paint is missing in spots, due to hot lading, such as pig iron, billets, cinders and blooms being loaded in cars, is not a cardable defect unless the damage is such as to require the shopping of the car.

Temporary Transverse Tie Rods Applied to Cars with Sides Spread or Bulged

Owners are responsible for the expense of applying tie rods, when these are necessary to allow the equipment to pass the clearance limits of the handling line.

DEFECTS OF VARIOUS PARTS OF CARS

Sills

Sills of both wood, steel, and steel underframe cars and cars with metal draft arms, should be carefully inspected to see that they are not destroyed, cracked or split on account of draft bolts working in sills or being buckled or broken. Broken, cracked and buckled sills are generally found directly in front of or at the back of the body bolster.

Method of Splicing Sills of Wooden System Freight Cars

Wooden Cars: Longitudinal sills may be spliced at both ends, except that not more than two adjacent sills may be spliced at the same end of the car. The splicing of any sills between cross tie timbers will not be allowed. The splice may be located either side of the body bolster, but the nearest point of any splice must not be within 12 in. of the

bolster, excepting center sills, which must be spliced between the body bolster and cross tie timber, but not within 24 in. of the body bolster.

The splicing of longitudinal sills other than center sills is to be done in accordance with Fig. 1; old splices now on cars may be repaired. Center sills must be spliced in accordance with Fig. 2, when new splices are used. This blueprint provides for a uniform splice for the various classes of cars and must be followed as far as practicable to obtain uniformity and interchangeability of splices. Old splices now on cars may be repaired.

Foreign and Private Line Cars: Longitudinal sills when broken may be spliced in accordance with the A. R. A. rules

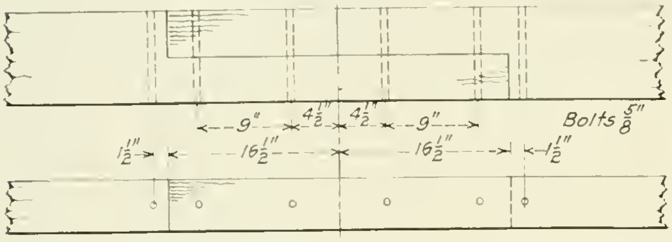


Fig. 1. Splice for Longitudinal Sills other than Center Sills

of interchange and the details of the splice must conform thereto.

Note: In splicing the sills of foreign and private line refrigerator cars, care must be exercised to see that the insulation is replaced in accordance with the original construction to avoid being penalized for wrong repairs, in the case of foreign equipment.

Center Plates

Body and truck center plates should be carefully inspected to see that they are not broken and properly secured in place, the bolts and nuts tight and the center pin in position properly secured to prevent loss when cars are turned over on dumping machines.

Truss Rods, Struts, Saddles, Washers and Nuts

On empty cars passing over repair tracks, through transportation yards or in storage, every opportunity should be taken to see that truss rods are properly tightened, so that

Arrangement of Draft Timbers and Wooden Center Sills

Draft timbers and sub-sills on empty cars on all repair tracks must be tightened up and other work done in accordance with standard car maintenance regulations, lock nuts to be applied to all bolts.

When applying new center sills, one keyway only must be cut in the sill, omitting the keyway nearest to the end sill. When applying new draft timbers, one keyway only must be cut in the timber; the keyway in the center sill corresponding to the keyway omitted in the draft timber should be filled with a piece of wood nailed in place. Draft timbers are to be framed and bear against the inside face of the end sill. The use of fillers between the bottom of the center sill and the top of the draft timber will not be allowed.

Cars with Low Center Line of Draft Gear

Every precaution must be taken in connection with cars having a low center line of draft, especially those cars not equipped with draft sills, in order to avoid the wheels interfering with the sills on curves, resulting in broken flanges. It often happens that cars which are difficult to inspect, on account of being low hung, do not receive the careful inspection of side bearings necessary, so that equipment proceeds with side bearings engaging each other, causing derailments.

Continuous Draft Gear

Cars are not acceptable in interchange when equipped with stem or spindle coupler attachments or American continuous draft rods.

Draft Gear

Inspection should be made to see that the draft gear and all its parts are in good condition, carrier irons and straps tight and in place. The coupler should be gaged to see that it is not worn beyond the limit permitted by the A. R. A. gage, also to see that it does not contain cracks that would result in failure. The coupler should be at the proper height as required by the federal Safety Appliance Law. Yoke rivets should be in place and tight. When new rivets are being applied at shops where the facilities are available,

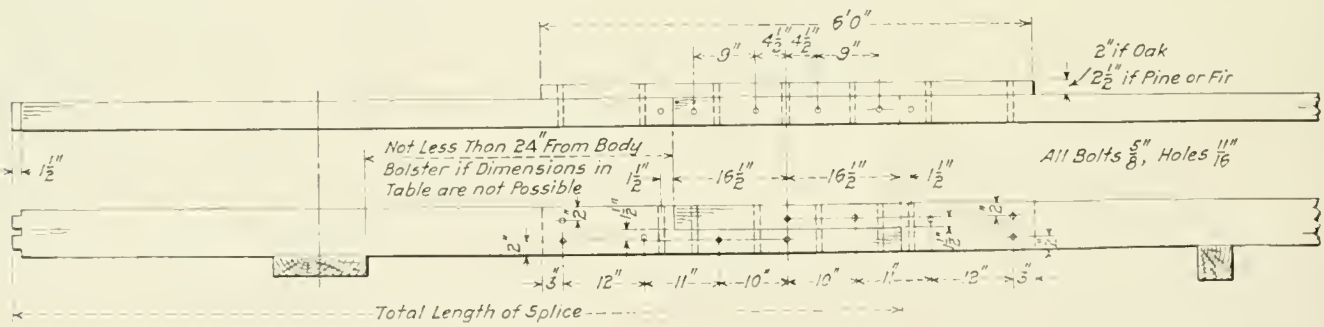


Fig. 2. Splicing of Center Sills in Conformity with the Rules of Interchange

the cars will have at least 1½-in. camber in the center. Turnbuckles should be properly secured from turning, truss rod saddles, struts and needle beams should be thoroughly held in place and should function properly at all times. Truss rods are to be tightened firmly in place and turnbuckles locked where possible; also saddles are to be properly located and the truss rod nuts on the end sill are to have full bearing and full thread hold.

Draft timbers. Draft timbers must *not* be spliced.

Draft Timber Bolts

Draft timber bolts 1⅛ in. in diameter must be applied to all system cars having draft timbers, center sills or draft rigging applied, these to replace ⅞-in. diameter bolts removed from empty cars on all repair tracks.

they should be 1¼ in. diameter in accordance with the A. R. A. requirements.

The coupler operating mechanism should be in operative condition so as to properly operate the coupler, to avoid safety appliance defects.

It is considered good practice to lubricate couplers as they pass over repair tracks by applying rail grease or the thick sediment taken from the bottoms of oil tanks, which may be applied with a paddle or a piece of waste fastened to a stick. This lubrication is applied to the wearing face of the guard arm of the coupler, and to the knuckle only where the knuckle throwing device bears, to assist in the free operation of the coupler. Care should be taken to keep lubricant off the knuckle lock and the bearing surface of both knuckle and lock.

(To be continued.)

SCHEDULING AND ROUTING WORK IN THE A. E. F. SHOP

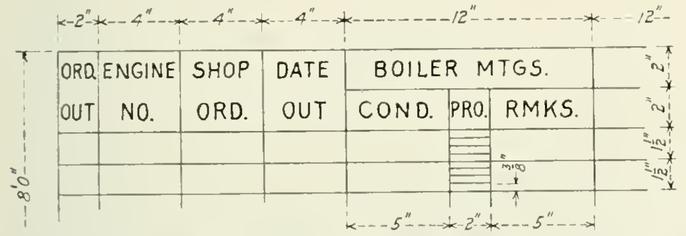
Methods Used to Increase Production in the Shop of the Railroad Engineers at Nevers, France

BY MAJOR C E. LESTER
Formerly Gen. Supt., 19th Grand Div., Transportation Corps, A. E. F.

THE writer has long been an advocate of systematic routing of parts in locomotive repair shops and is at the present time more than convinced that routing and scheduling of parts is a practical necessity in a shop on a day-work basis that is of such a size that the machine shop foreman particularly and all other department foremen in general do not know from actual contact the exact status of individual pieces of work.

In shops where no routing system is in effect some pieces of work invariably get buried or lost from sight until the part is actually needed, with the result that the foreman must pay penalty overtime to get the work ready or delay the locomotive for which it is needed. In any case, no system means lack of system and co-operation, with inevitable delay due to haphazard methods.

The routing and scheduling system and the machine-shop percentage board, presented herewith, were inaugurated under the writer's direction in the Nevers, France, locomotive shop to expedite repairs. Incidentally, no claim is made for originating this method. The system was not new, but rather an application of principles of routing used here in the states in various shops, and was worked out "over there" by men in the shop who had come in contact with such systems in the U. S. A.



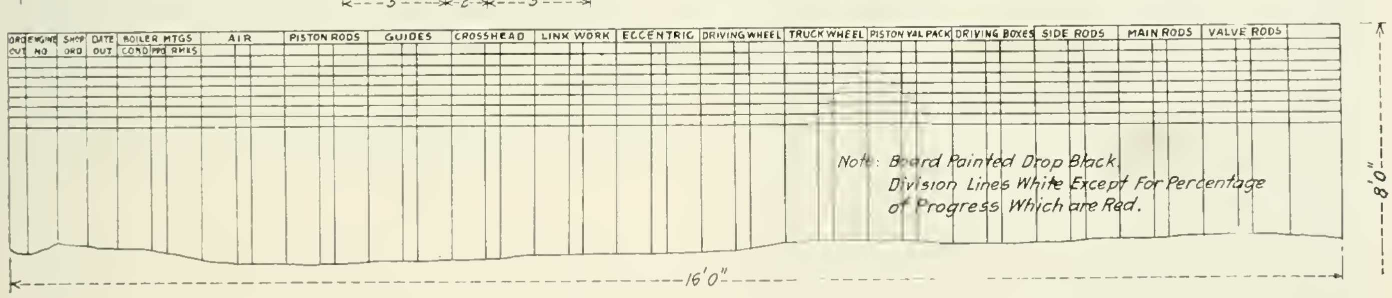


Fig. 1. Percentage Board for Recording Progress of Work

The shop was new, the organization was in an embryonic stage, our soldier mechanics were men of unknown ability and experience, our gang leaders were trial selections, the department foremen (commissioned officers) were an unknown quantity, there were no opportunities to go out and select, no time to waste on lengthy educational methods, we had what we had and got nothing else.

The necessity for a smooth-running shop and the maximum output possible was a fact so apparent that there was no disguising the necessity of devising ways and means of crowding the work to the extreme limit. The shop was the only all-American locomotive repair shop in France, completely officered and manned by soldier mechanics of the American army, and as the French shops were run down and depleted of workmen it was the only shop in France where the 1 160 Pershing engines and the 476 Belgian U. S. A. engines could get anything except running repairs. It was also required to handle heavy repairs for the Est., Paris-Orleans, Nord and Paris, Lyons & Mediterranean railways as well as all types and sizes of narrow-gage locomotives (French, Belgian and German), road rollers, tractors, pile drivers, locomotive cranes and the assembly of forestry locomotives.

It is an undisputed fact that method and system are the greatest producers. After about four weeks of operation without what could be called a definite plan of operation, this system was put on trial. Its results were at once apparent and almost immediately justified its adoption in many ways, one in particular being that the general foreman had his finger on the pulse of the organization at all times and, like a general with his war maps and service of information, could plan his strategic moves to the confusion of his old enemy—haphazard methods.

It is a well-understood fact that (a) methods of application and (b) sympathy or the lack of it are the prime movers in establishing any system. This system met with a hearty and enthusiastic reception, which insured its success from its inception.

The method (so called) prior to the adoption of the scheduling and routing system was the custom of establishing a completion date for each locomotive undergoing repairs. This practice is the usual one where the erecting shop foreman looks over the inspection report for the locomotive concerned and "reckons as how" he can get the engine out in an estimated number of days. He has no reliable detailed data on the status of work in the various departments, no particular method of calculation; he bases the date on his experience of the time it should take to complete the repairs, but, like the weather prophets, he occasionally makes a good guess.

There are evidently three factors that must be carefully considered and conscientiously performed to make the scheduling and routing system function properly. First, the joint inspection by boiler and machinery inspectors should be a most thorough and competent one, as it is on this that the "schedule engineer" bases his figures, and a poor inspection will upset all calculations and incidentally the whole shop schedule.

Second, the constants used for individual locomotives and their various parts must be obtained by thorough, careful consideration of all conditions that affect the progress of parts through the shop. A constant sheet worked up for one

shop would be valueless in another unless conditions were very similar.

Third, the schedule engineer or routing clerk, as he is variously called, must be thoroughly familiar with shop conditions and facilities; he must have sufficient mechanical ability to carefully judge the progress of work in order to successfully check the work; he must at all times keep in mind the fact that any newly established sytem ceases to be an innovation after a short time and that as it ages it should become freer running and can be speeded up, and should be in position to shorten up time here and there in order to force production; the summary of these qualifications is that he must be a worker and a schemer.

In connection with the operation of the system a photograph of the locomotive shop chart of February 1, 1919, is shown, with the output of classified repairs for the months of December, 1918, and January, 1919, shown on the right

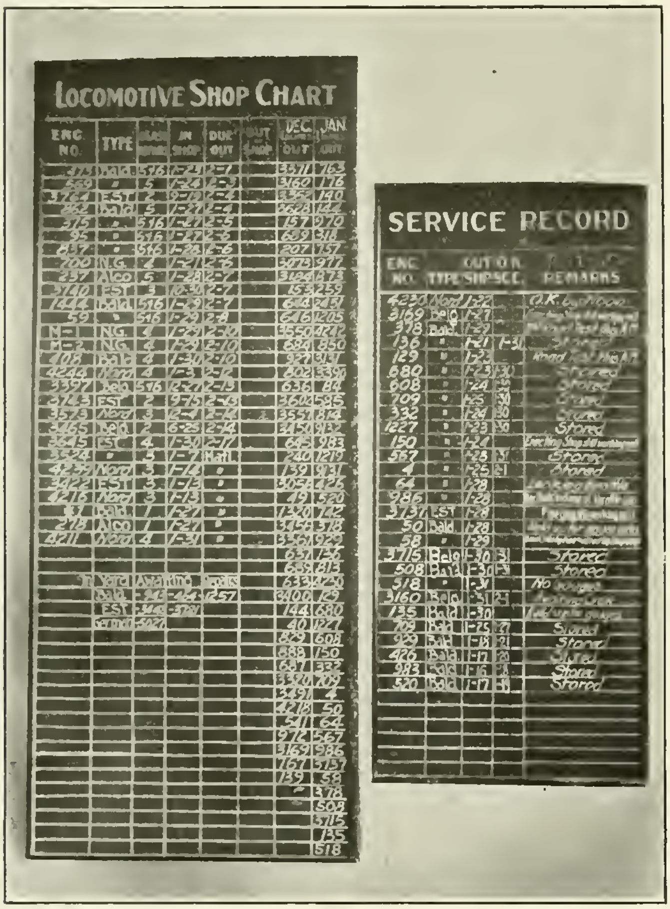


Chart of Classified Repairs, Nevers Shop, Feb. 1, 1919

of the board, a total of 45 and 50, respectively, an increase from 14 in August and 21 in September.

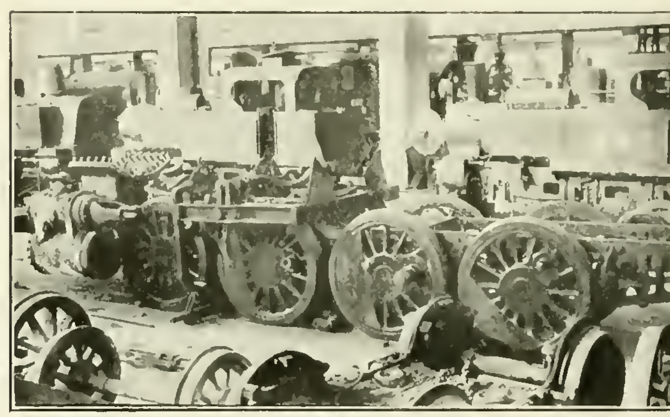
The service record board was used to show all locomotives on hand in the shop yard each day until the locomotive left the premises. It will be noted that but 28 locomotives were booked for February. This is explained by the fact that 500 men were ordered back to the states on February 1, 1919.

Material Checking System

On account of the great number of locomotive parts necessarily handled in the machine shop and the possibility of some of these parts being allowed to remain at any one machine a longer time than necessary, thus delaying the completion of the locomotive in the erecting shop, a material checking system was instituted so as to be in position at all times to tell without difficulty the exact status of all work in this shop. The appurtenances of this system consist of a percentage board, located in the machine shop foreman's office, shown in Fig. 1, and a record kept by each gang leader, Fig. 2.

The sketch of the percentage board explains itself insofar as the general design of the board is concerned. It is only necessary to add an explanation of the method employed in working the board. In the column headed "Order out" are listed all locomotives undergoing repairs in the erecting shop in the order in which they are due out. This is used to determine at a glance whether the work in the machine shop is progressing properly, so as not to delay the assembling of any certain locomotive in the erecting shop. The next two columns are self-explanatory. A column for shop order numbers is necessary at these shops, as a shop order is issued for each locomotive repaired and all labor and material charged to the shop order number instead of to the locomotive number. In the column headed "Date Out" is placed the date the locomotives are due out of the erecting shop.

The remainder of the board, it will be noted, is divided into columns for the various locomotive parts, each having three sub-columns, namely, condition, progress and remarks. In the first column is placed the condition of the part when received in the machine shop. In the column headed "Progress" are shown figures to denote what per cent the work has progressed. When work is started on any part the figure 25 is placed on the first line of this column, indicating



A Scene in the Erecting Shop

that the work has progressed 25 per cent. Parts sent to the machines or parts received back from the babbitting shop or other shops, where they have been forwarded for repairs, are considered as 50 per cent complete, and that figure is placed on the second line. Parts sent from machines to the bench gangs are considered as 75 per cent complete, and that figure is entered on the third line. When the parts are completed 100 per cent is placed on the fourth line. Lesser divisions of progress could easily be used, but it was found that four 25 per cent divisions were small enough for our purpose.

The question that will naturally arise after the above explanation is from what source the information is received as to the progress, so that the entry can be made on the percentage board. This information came from the records kept by the various gang leaders, on the form shown in Fig. 2. Each gang leader had one of these forms on which he entered the progress of the work of his gang and which he turned in at the close of each working day. From this form the clerk in the machine shop foreman's office entered the information on the percentage board.

The column headed "Remarks" was used in cases where locomotives had been scheduled and the parts had not been received in the machine shop, etc. In such cases the word "None" was entered in this column. In cases where parts were received in the machine shop and work on them had not

been started the word "Over" was placed in this column. When parts were sent to other shops to receive repairs and were later to be returned to the machine shop for completion, the shop to which the parts were forwarded was written in this column.

The percentage board enabled the machine shop foreman to readily ascertain the progress of all work in his shop, and if the work was not progressing as it should so as to enable the erecting shop to complete the locomotive by the scheduled date, he could take such steps as would be necessary to bring about the completion of the work in the proper time. This system has proved of great assistance in the supervision of the machine shop.

Locomotive Scheduling and Material Routing System

Frequent delays were experienced, causing necessity for a change in the established date for the completion of locomotives, through the failure of one or more of the shops to finish their work on parts prior to the time they were needed by the erecting shop for application to the locomotives.

In order to overcome this hindrance in the progress of completing locomotives, the "routing" and "scheduling" system was placed in operation during the month of August, 1918. By "routing" is meant the determining of a route or path over which the parts must necessarily pass in the course of repairs. By "scheduling" is meant the establishing of a date when each part is to be received in a certain shop and a date for that shop to complete its work on the parts and pass it on to the next shop. This "routing and scheduling" system was handled entirely by a route clerk and one assistant. It may be well to add that these men were mechanics of known ability to competently judge the status of the work, time required, etc.

Immediately upon receipt of locomotives at the shops for repairs a joint inspection was made by a boiler inspector and a locomotive inspector, who after the completion of their inspection made a joint report to the general foreman showing the principal repairs required. This joint inspection report when received by the general foreman was passed on to the route clerk, who was located in the general foreman's office, with necessary instructions as to the date and location for the engine. From this joint report the route clerk determined the class of repairs that were to be made and the number of days it should take to complete such repairs. The schedule of classification and the number of days allowed for each class of repairs in effect at the shops were as follows:

Class	Nature of Work	Number of Days
One	New engine (rebuilt)	Twenty-eight or more.
Two	New firebox and general repairs	Twenty to thirty.
Three	Light repairs to firebox, flues changed and heavy repairs to machinery	Ten to twenty-four.
Four	Tires changed or turned, driving boxes renewed, and other necessary repairs to machinery	Six to eighteen.
Five	Running repairs (heavy)	Two to ten.
Six	Accident repairs	Depending entirely on extent of damage.

For each class of repairs there was a more or less definitely established "Mastersheet." For the type of master sheet used reference is made to Fig. 3, compiled for a Consolidation type locomotive requiring class Three repairs and scheduled to be completed within 24 days. It will be noted that each shop has its column wherein are listed the various parts of the locomotive handled by that shop. The figure appearing opposite each item is the scheduled number of days for the completion of each operation. For example; the figure two opposite "Engine Stripped" in the erecting shop column, indicated that the erecting shop is to have the locomotive stripped and material delivered two days after the engine arrives in that shop.

The class of repairs, and number of days in which to complete the repairs having been determined, the next step is to inform the various shop foremen when the various operations

Ord. out	Engine No.	Shop ord.	Date out	Boiler m'tgs.	Air	Piston rods	Guides	Cross heads	Link work	Eccentrics	Drvg. wheels	Truck wheels	Piston valve pkg.	Drvg. boxes	Side rods	Main rods	Valve rods
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

Fig. 2. Record Kept by Gang Leader

Schedule for 24 Day Locomotive

Erecting shop	
Eng. stripped	2
Boiler off	4
Cyl. stripped	4
Frame Bolted	18
Shoes and wedges laid off	15
Boiler Mounted	18
Boiler fittings applied	16
Dry oipe in	16
Cyl. bushings in or bored	18
Valve bushings in or bored	18
Boiler tested	19
Guides and crossheads up	20
Boiler lagged and jacketed	20
Engine truck O. K	19
Engine wheeled	20
Motion work up	21
Sup'heater units appl. & st. pipe	22
Valves in and out	22
Main and side rods on	23
Brake rigging applied	22
Cab and cab work applied	23
Pipes O. K	24
Ash pan and grates O. K	23
Tender coupled to engine	24
Engine out	24
Frames	—

Machine shop	
Cylinders	15
Frame braces and pads	16
Boiler fitting	14
Shoes and wedges for laying off	13
Cyl. bushings	17
Valve bushings	17
Guides and crossheads	18
Driving boxes	18
Motion work	19
Shoes and wedges	19
Pistons	19
Valves	19
Main rods	21
Cab work	21
Side rods	21
Air brake equipment	21
Driver brake rigging	20
Tender parts	19
......	..
......	..
......	..
......	..
......	..
......	..
......	..

Boiler shop	
New fire box	
Flues applied	18
Boiler tested	19
Ash pan O. K	23
Tender O. K	22
......	..
......	..
......	..

Forge shop	
Frames	
Binders	14
Motion work	8
Spring Rigging	19
Main and side rod	7
Brake rigging	11
Eng. tank parts	14
Tender parts	19
......	..
......	..
......	..
......	..
......	..
......	..

Wheel shop	
Engine truck, wheels and boxes	17
Driving wheels and boxes	17
Tender truck, wheels and boxes	19
......	..
......	..
......	..

Pipe and jacket shop	
Jacket O. K	21
Pipes O. K	24
Cab O. K	22
......	..

Tender shop	
Tender parts	20
Tender trucks and frame O. K.	21
Cistern O. K	22
Tender O. K	23
Tender coupled to engine	24
......	..
......	..
......	..
......	..
......	..

Fig. 3. Schedule for a Locomotive to be Completed in 24 Days

in their respective shops are to be completed. This is accomplished by the use of a repair card, shown in Fig. 4. This repair card is compiled by the route clerk and distributed to the various shop foremen concerned. Using the master sheet as a guide, showing the number of days in which each operation is to be completed, the repair card is compiled to show the day of the month on which each operation is to be completed. Fig. 4 is the repair card for the machine shop and it will be noted that there is listed thereon the date each part is to be received from another shop and also the date that it is to be completed and passed on to the next shop concerned.

Similar repair cards are furnished the various other shop foremen, Fig. 5 showing the form for erecting shop, Fig. 9 for the smith shop, Fig. 6 for the boiler shop, Fig. 10 for the tank shop, Fig. 7 for the wheel shop and Fig. 8 for the pipe and welding shop. These repair cards enable each shop foreman to know at all times just what work he has ahead of him and by what date the various items must be completed so far as his shop is concerned, and passed on to the next shop for further work, and so on until completion, when the part will be returned to the erecting shop to be applied to the locomotive undergoing repairs, on such a date as to make it possible to get the locomotive out of shop on the scheduled date.

As a ready method of arriving at the day of the month on which each operation is to be handled in the various shops from the master sheet, showing the number of days instead of the dates, as previously explained, a calender rule is used (Fig. 13). This rule has a slide through the center ruled off in squares numbered consecutively from 1 to 45 inclusive, 45 days being considered the approximate maximum time a locomotive will remain in these shops. Above and below the slide are pasted sheets ruled in squares corresponding in size to the squares on the slides and numbered consecutively for each day of the month, Sundays and holidays eliminated. This rule provides for a three month period at one time, at the expiration of which, new ruled sheets for the next three months are placed on the rule taking the place

MACHINE SHOP REPAIR CARD.

Issued to.. ....Foreman

Engine No... ....
S. O. No................. ......
Date in, 10-28-18
Date out, 11-30-18

Class of work	Wanted from erect shop	Wanted in erect shop	Wanted in smith shop	Wanted from smith shop	Wanted from tank shop	Wanted in tank shop
Engine frames	....	....	....	....	....	....
Side rods	10-29-18	11-21-18	11- 1-18	11- 5-18	....	....
Frame braces and pads	10-29-18	11-15-18	....	....	....	....
Boiler fittings	10-29-18	11-13-18	....	....	....	....
Cylinder bushings	....	11-16-18	....	....	....	....
Valve bushings	....	11-16-18	....	....	....	....
Guides and crossheads	10-29-18	11-18-18	11- 1-18	11- 4-18	....	....
Driving boxes	10-29-18	11-18-18	....	....	....	....
Motion work	10-29-18	11-19-18	11- 4-18	11- 7-18	....	....
Shoes and wedges	10-14-18	11-19-18	....	....	....	....
Pistons and valves	10-29-18	11-19-18	....	....	....	....
Main rods	10-29-18	11-21-18	11- 1-18	11- 5-18	....	....
Cylinders	11- 1-18	11-14-18	....	....	....	....
Cab work	10-29-18	11-21-18	....	....	....	....
Air brake equipment	10-29-18	11-21-18	....	....	....	....
Engine brake rigging	10-29-18	11-20-18	11- 2-18	11- 9-18	....	....
Engine truck wheels	10-29-18	11-16-18	....	....	....	....
Driving wheels	10-29-18	11-16-18	....	....	....	....
Tender wheels	....	....	....	....	10-29-18	11-19-18
Tender parts	....	....	....	....	10-29-18	11-19-18
Tender brake cylinders	....	....	....	....	10-29-18	11-19-18

Fig. 4. Typical Form of Date Shown on Machine Shop Repair Card

ERECTING SHOP REPAIR CARD

Engine No............. ....
S. O. No..............................
Date In 10-28-18
Issued to ....Foreman. Date Out 11-30-18

Class of work	Date wanted	Class of work	Date wanted
Engine stripped and material delivered	10-29-18	Engine truck O.K.	11-19-18
Boiler delivered to boiler shop	11- 1-18	Engine wheeled	11-20-18
Boiler in shop mounted.	11-18-18	Motion work up	11-21-18
Frames Bolted	11-18-18	Superheater units appl and steam pipes O.K.	11-22-18
Cylinder stripped	11- 1-18	Valves in and set	11-22-18
Shoes and wedges laid off	11-14-18	Main and side rods on.	11-23-18
Boiler fittings applied	11-15-18	Spring rigging O. K.	11-19-18
Boiler test (water)	11-19-18	Brake rigging applied O. K.	11-22-18
Boiler test (steam)	11-20-18	Pipes O. K.	11-24-18
Cylinder bushings in or bored	11-18-18	Ash pan and grates O.K.	11-23-18
Valve bushings in or bored	11-18-18	Cylinder welded	....
Guides and crossheads up	11-20-18	Flat spots welded	....
Boiler lagged	11-20-18	Engine out	11-24-18
Boiler jacket O.K.	11-21-18		

Fig. 5. Erecting Shop Repair Card

BOILER SHOP REPAIR CARD

Eng. No...........
Date In, 10-28-18
S. O. No..........
Issued to .... Foreman. Date Out, 11-30-18

Class of work	Wanted in erect shop	Wanted from erect shop	Wanted from tank shop	Wanted in Tank Shop
New fire box..	....	....	....	....
Flues applied..	11-18-18	....	....	....
Boiler tested..	11-19-18	....	....	....
Ash pan O.K.	11-23-18	....	....	....
Steel run boards O.K..	11-15-18	11-1-18	....	....
Tender tank O.K.	....	....	11-22-18	....

Fig. 6. Boiler Shop Repair Card

WHEEL SHOP REPAIR CARD

Eng. No..........
S. O. No..........
Date In, 10-28-18
Issued to .... Foreman. Date Out, 11-30-18

Class of work	Wanted from erect. shop	Wanted in erect. shop	Wanted from tank shop	Wanted in tank shop
Driving wheels	10-29-18	11-16-18	....	....
Engine truck wheels.	10-29-18	11-16-18	....	....
Tender wheels	....	....	10-29-18	11-19-18

Fig. 7. Wheel Shop Repair Card

PIPE, JACKET AND WELDING SHOP REPAIR CARD

Eng. No..........
S. O. No.........
Date Out, 11-30-18
Issued to .... Foreman. Date Out, 11-30-18

Class of work	Work to be finished	
Boiler jacket	11-21-18	....
Pipes O. K.	11-24-18	....
Babbitt work finished	11-4-18	....
Cylinders welded	....	....
Cab O. K.	....	....

Fig. 8. Pipe, Jacket and Welding Shop Repair Card

of the ones for the previous three months. By placing the slide so that number one is opposite the day of the month in which the locomotive was placed in the shop for repairs the date each operation is to be accomplished can readily be determined. For example, assume a locomotive arriving October 28, requiring class Three repairs, the scheduled date for which has been set at 24 days. Reference to the master sheet, Fig. 3, will show that the boiler fittings are to be applied within 16 days. By placing the slide so that number one will be opposite October 28, one will readily see that this operation must be completed on or before November 15.

Blacksmith Shop Repair Card

Engine No.........................
S. O No.........................
Date in 10-28-18
Date out 11-30-18

Issued to .... Foreman.

Class of work	Wanted from Mach shop	Wanted in mach. shop	Wanted from erect. shop	Wanted in erect. shop	Wanted from tank shop	Wanted in tank shop
Engine frames						
Frame binders			11- 1-18	11-13-18		
Motion work	11- 4-18	11- 7-18				
Spring rigging			11-29-18	11-19-18		
Main and side rods	11- 1-18	11- 5-18				
Engine brake rigging	11- 2-18	11- 9-18				
Engine truck parts			11- 1-18	11-13-18		
Tender parts					11- 1-18	11 19-18
Guides	11- 1-18	11- 5-18				

Fig. 9. Blacksmith Shop Repair Card

TANK SHOP REPAIR CARD

Eng. No...........
S. O. No..........
Date In, 10-28-18
Date Out, 11-30-18

Issued to .... Foreman.

Class of work	Wanted in tank shop	Wanted for engine	Wanted in machine shop	Wanted from machine shop	Wanted in smith shop	Wanted from smith shop
Tender	10-28-18	11-30-18				
Tender trucks and frame O. K	11-21-18					
Cistern O K	11-22-18					
Tender wheels			10-29-18	11-19-18		
Tender parts			10-29-18	11-19-18	11-1-18	11-9-18
Engine truck O. K		11-19-18				

Fig. 10. Tank Shop Repair Card

In the general foreman's office a "Despatch Board" is located. This board is fitted with a slide rule, ruled off, a space being provided for each locomotive part, listed in the same order as it appears on the master sheet. Tacked to the board is tracing paper ruled off in squares corresponding in size to the ruling on the sliding rule. In the first column to the left are placed the dates of the month, Sundays and holidays excluded. When a locomotive is scheduled the route clerk enters the locomotive number on the despatch board in the square opposite each item to be handled and the date on which each item is to be completed in the various shops. For instance in the case we have considered throughout this explanation, the boiler fittings of this locomotive are to be applied by November 15. In posting the despatch board the slide rule will be placed on a line with the fifteenth day of the month, and in the square parallel with "Boiler Fittings" will be placed the locomotive number. Should it occur that a locomotive part is not completed by the date it is scheduled for completion, the number is carried forward in red ink to the next day and so on until the operation is complete.

Erecting Shop Operation Check List

.... 19..

Engine No.	Operation	Cause of delay
......	Engine stripped and material delivered.	
......	Boiler delivered to boiler shop..	
......	Boiler in shop mounted........	
......	Frames bolted	
......	Cylinder stripped	
......	Shoes and wedges laid off.....	
......	Boiler fittings applied.........	
......	Boiler test (water)...........	
......	Boiler test (steam)...........	
......	Cylinder bushings in or bored..	
......	Valve bushings in or bored....	
......	Guides and crossheads up......	
......	Boiler lagged	
......	Boiler jacket O. K...........	
......	Engine truck O. K............	
......	Engine wheeled	
......	Motion work up.............	
......	Superheater units applied and steam pipes O. K.	
......	Valves in and set............	
......	Main and side rods on.......	
......	Spring rigging O K..........	
......	Brake rigging applied O. K....	
......	Pipes O. K................	
......	Ash pan and grates O. K......	
......	Cylinders welded	
......	Flat spots welded...........	
......	Engine out	

Fig. 11. Form for Checking Operations in the Erecting Shop

Machine Shop Material Check List

.... 19..

Engine No.	Days late	Material	Where due	Remarks
......	......	Engine frames and parts..	E.S.	
......	......	Cylinders	E.S.	
......	......	Boiler fittings	E.S.	
......	......	Cylinder bushings	E.S.	
......	......	Valve bushings	E.S.	
......	......	Guides and crossheads...	E.S.	
......	......	Driving boxes	E.S.	
......	......	Motion work	E.S.	
......	......	Shoes and wedges........	E.S.	
......	......	Pistons and valves.......	E.S.	
......	......	Main rods	E.S.	
......	......	Side rods	E.S.	
......	......	Cab work	E.S.	
......	......	Air brake equipment.....	E.S.	
......	......	Engine brake rigging.....	E.S.	
......	......	Engine truck wheels......	E.S.	
......	......	Driving wheels	E.S.	
......	......	Tender wheels	T.S.	
......	......	Tender parts	T.S.	

Fig. 12. Machine Shop Material Check List

This despatch board enables the general foreman to tell at a glance just what locomotive parts are due for completion on any certain day, and indicates to him and others concerned, just what parts are delaying the completion of the locomotive in the erecting shop.

Each morning the route clerk refers to the despatch board and determines therefrom what operations should have been completed at the close of the previous working day and enters on a check list the locomotive numbers opposite each item that should have been completed. The check lists used for the erecting shop, machine shop, for all other shops, are

shown in Figs. 11, 12 and 14 respectively. The route clerk then visits the various shops determining whether or not the operations have been completed. If completed a line is drawn through the locomotive number. If not completed, an explanation and the prospective date of completion, are secured from the foreman in charge of the shop wherein the delay has occurred and this information is entered on the check list in the column headed "Cause of Delay" or "Remarks." When this morning check has been completed reports are rendered to the general foreman, on the form in Fig. 15, showing delayed operations in the erecting shop, and Fig. 16, showing delayed operations in all other shops. These reports place the general foreman in a position to know what work is being delayed or likely to be delayed, and his investigation can be instituted in sufficient time to cause action to be taken that will bring about the completion of the locomotive on the scheduled date.

This system of routing and scheduling had decided advantages over the former system, and brought about very beneficial results, the most important result obtained being that for which the system was originated, namely, the elimination of holding locomotives in the shops past their scheduled date.

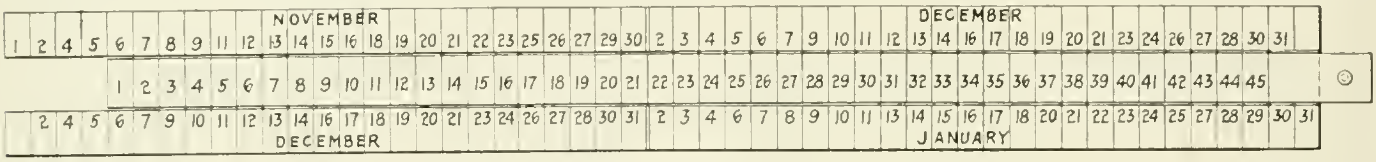


Fig. 13. Calendar Rule for Scheduling Work

Blacksmith, Boiler, Tank, Pipe, Jacket and Cab Shops Material Check List

.... 19..

Engine No.	Days late	Material	Where due	Remarks
.....	.....	Engine frame	M.S.	....
.....	.....	Frame binders	E.S.	....
.....	.....	Motion work	M.S.	....
.....	.....	Spring rigging	E.S.	....
.....	.....	Main and side rods	M.S.	....
.....	.....	Eng. brake rigging	E.S.	....
.....	.....	Eng. truck parts	E.S.	....
.....	.....	Tender parts	T.S.	....
.....	.....	Guides	M.S.	....
.....	.....	New fire box	B.S.	....
.....	.....	Flues applied	E.S.	....
.....	.....	Boiler tested	E.S.	....
.....	.....	Ash pan O. K.	E.S.	....
.....	.....	Steel run. boards	E.S.	....
.....	.....	Tender tank O. K.	T.S.	....
.....	.....	Tender O. K.	T.S.	....
.....	.....	Tender due for eng.	E.S.	....
.....	.....	Jacket O. K.	E.S.	....
.....	.....	Pipes O. K.	E.S.	....
.....	.....	Cab O. K.	E.S.	....
.....	.....	Babbitting finished	P.S.	....
.....	.....	Cylinder welded	E.S.	....

Fig. 14. Miscellaneous Shop Checking List

.... 19..

General Foreman

Note statement of Erecting Shop operations late to date:

Eng. No.	Operation	Days late	Cause of delay
....	....	....	....
....	....	....	....

Fig. 15. Form for Reporting Delays in the Erecting Shop

.... 19..

General Foreman.

Note statement of finished material late in delivery to date:

Eng. No.	Material	Where delayed	Days late	Cause of delays
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

Fig. 16. Form for Reporting Delayed Material

TRACK STOPS FOR ROUNDHOUSES

BY NORMAN MAC LEOD

It frequently happens, due to carelessness or poor judgment on the part of railroad employees, that locomotives are run too far in a roundhouse or other points in railroad shops or yards, resulting in the locomotive being derailed or in damage to the buildings. To overcome this trouble two designs of track stops have been put in use in a number of roundhouses on one of the larger railroads and have proved very effective. The material used for both of these stops is cast steel.

The stop shown in Fig. 1 is made in right and left hand

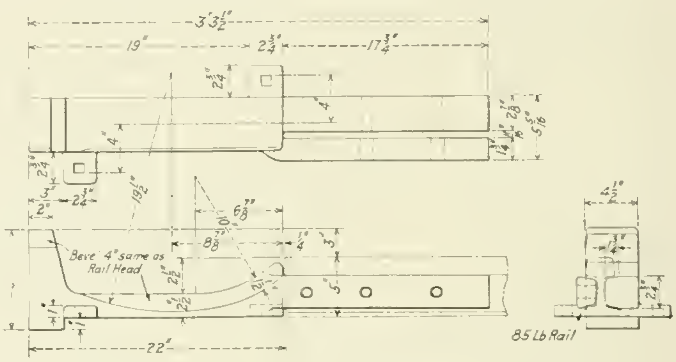


Fig. 1. One Piece Track Stop for Application at the End of the Rail

patterns, and is intended for use at the end of a track. It is provided with an extended concave portion to receive the wheel and stop the locomotive should it be run too far. The other type of stop, as shown in Fig. 2, is made in two parts,

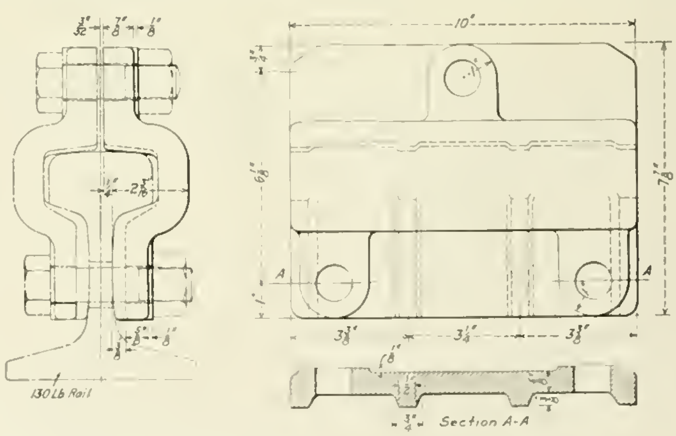


Fig. 2. Two-Piece Track Stop for Application at Any Point on the Rail

which are bolted to and project above the rail head. It can be applied to the rails at any point that may be desired, even at the joint between two rails.

The use of such stops will prevent many expensive and dangerous accidents, and track stops made to these designs or other similar devices should be used wherever such trouble has been experienced.

Fools Rush In Where Angels Fear to Tread*

The General Manager Gets Some Inside Dope on Causes of the High Cost of Locomotive Repairs

BY HUGH K. CHRISTIE

Gibbons, the general foreman read and re-read the announcement. Reflectively he laid down the railroad magazine and stared vacantly at the red-lettered cover. His clerk eyed him curiously.

"Any local news along the line this month?" he finally asked as he pushed over Gibbons' mail.

"Nothing at Grand Falls," responded the boss, "but an article here has got me thinking. The general manager says he'll give a fifty dollar prize to any railroad employee who will send him direct the best write-up on savings in any department on the road."

"Why don't you give him some dope?" said Leary, the clerk. "You and me have been watching leaks every day around here for some years and now's your chance. Fifty dollars is fifty dollars you know."

Gibbons shook his head. "Don't pay, Leary," he replied. "If we knew as much about saving as the big fellows did why—why, we'd be on their jobs. You know how I get bawled when I start suggesting. I would like to tell them a few things, though," he added absently.

"And the fifty dollars, too," reminded Gibbons' understudy.

"Ain't the money," said the boss, "but I would like to poke up a hornets' nest around here and get some material. Say, save that magazine for my noon hour," he abruptly commanded—"I'm going to the store," and the foreman pulled on his hat and started through the shop toward the little office at the end of the long brick store building.

Gibbons gave no heed to what was taking place about him, as he swung down the pit-side. The general manager's announcement kept pounding in his brain. He did not care to tell Leary that the fifty dollars meant more to him than the voicing of his protest against inefficient performance. He wanted those fifty iron men and wanted them badly. Wasn't he going to the community dance in a week and wouldn't he have to be all dolled up? Fifty dollars would do the trick nicely without cutting a hole into his two weeks' check. The idea was how to go about it, for William Gibbons was no hand to produce exploded verbal kicks in polished written form for a G. M. to read.

He swung open the door to find the storekeeper in conference with a visitor, who was recognized at once by the sharp-eyed boss. It was Case, the general storekeeper.

"How are you, Mr. Gibbons," he said as he reached for Bill's hand. The enthusiasm, however, was all on his side. With a gruff, "howdy" the foreman turned his attention to the storekeeper.

"Say," he announced, "we're all out of D. S. 5 springs for Engine 397. She was due out tomorrow—I've got her wheeled and blocked waiting for 'em."

The storekeeper looked wearily at Gibbons and then turned toward his own boss for some suggestion.

"Hear about this before?" asked the general storekeeper.

"Yes," replied the local man. "I wired to Sagum Hill but didn't get an answer."

The general storekeeper looked toward the frowning foreman. "Why—why don't you get some out of the scrap."

"I knew it!" exploded Gibbons. "All I hear around here is, 'Look in the scrap!' Good Lord! what you fellows doing these days? Running the store department on scrap! Say, I got a limited pay roll on labor and I ain't got no time to waste hunting scrap."

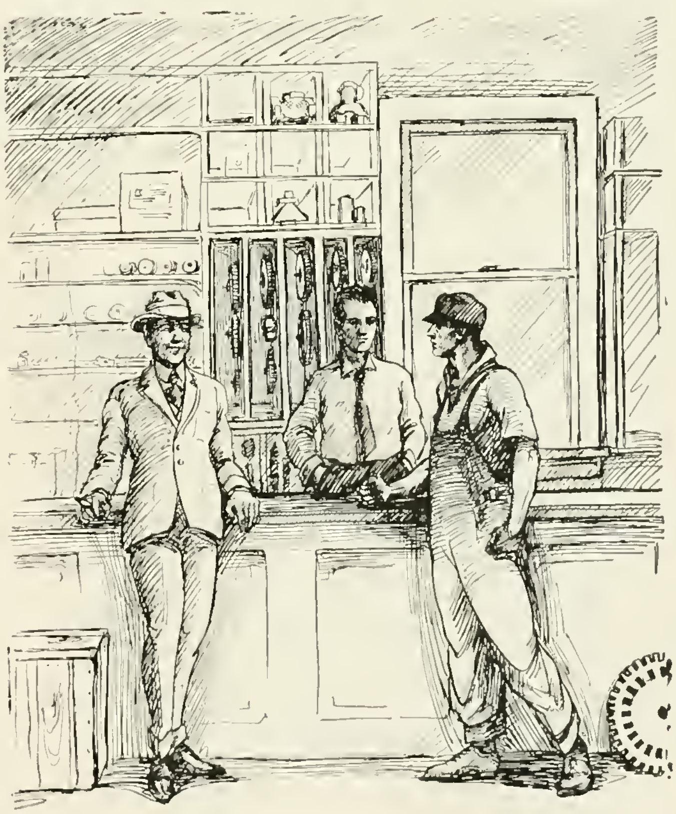
The general storekeeper laughed easily.

"Don't get excited, Mr. Gibbons," he remarked. "We have got our limits to work inside, ourselves. The proportion must be maintained, you know."

"Proportion! What proportion?" growled the shop foreman.

"The proportion between material and labor in railroading," smoothly responded the general storekeeper as he relit his half consumed cigar and regarded Bill, the foreman, complacently.

"You see it's just like this," he continued, noting Gibbons' blank look. "Material should run about 40 per cent and labor 60 per cent on your cost of back shop repairs. At the present time we are maintaining our figures, but the mechanical department has gone way beyond theirs. From this it is evident that the store department is more efficient than



"We're All Out of D. S. 5 Springs for Engine 397."

your department, and that is why I suggested that you look the scrap pile over for waste of material."

The local storekeeper expected one of Bill's daily brain storms over shortage of material but none was forthcoming. In silence Gibbons rubbed his chin and stared reflectively at the visitor.

"Those the customary figures?" he finally questioned.

"They certainly are," responded Case. "Any complaint against them?" he added.

"Don't know," remarked the shop boss thoughtfully. "I do know one thing, however, and that's this: The store department always makes a hit when it cuts down material no

*Entered in the Railway Mechanical Engineer prize story contest.

difference how it affects the mechanical department, which can't squeal because it has always been considered the non-revenue end of the pike. My boss is trying to save money by getting more material and your boss, the purchasing agent, is cutting requisitions. If it comes to a show down the store wins out.

"You store fellows are always talking about saving and reclaiming scrap," continued Bill, "but I say, why don't you get decent material that won't have to be scrapped. We order one thing and get something else."

The general storekeeper blew out a puff of smoke and grinned.

"Better tell the general manager about these things, Mr. Gibbons, and see who is right," he finally remarked.

For a solid minute the shop boss stood staring vaguely beyond the speaker. Evidently the general storekeeper had not seen the announcement in the magazine. Suddenly Gibbons started for the door. As he started to close it he turned first to the storekeeper. "Chase those springs, Bill?" he requested. Then a sharp glance toward Case. "Thanks for your advice you gave me a second ago—believe I will give the G. M. a few tips." Without another word he disappeared.

Gibbons went through the rest of the working day automatically. No one noticed that he acted peculiarly different, but his clerk appeared surprised when Gibbons asked him to get the cost sheets for overhauling back shop locomotives by months for the past year. Leary was further puzzled to see his boss carefully roll up the data and take it home that night with a mass of notes which the under foreman had submitted.

Throughout the evening meal the boss was unusually quiet. It worried his wife.

"Anything wrong at the shop today, Bill?" she anxiously asked.

"Nothing out of the usual, Peggy," came the response. "But I'll be busy on some work tonight and I'm just checking it off in my brain."

"Is it for the shop?" she questioned.

A grim smile came over her man's face. "Maybe, and maybe not—maybe I'm digging my own grave, but what I'm figuring on doing is writing the general manager for a suit of clothes. I'll either get them or get something else that I ain't looking for."

Bill would not satisfy his wife by answering any other question, and as soon as the dishes were cleared from the table he produced his railroad papers. Patiently he worked over locomotive costs of heavies and lights. He had repairs running from five hundred to four thousand dollars. Carefully he separated the labor and material costs grunting astonishment at his results. He whispered an oath at the final averages.

In repairing power *90 per cent represented labor and only 10 material.* On a $2,000 repair job only $200 was used for material. Gibbons discovered that on a basis of 40 per cent for material and 60 per cent for labor $500 should be the proper labor charge. Instead, it was $1,800. It was $1,300 too much.

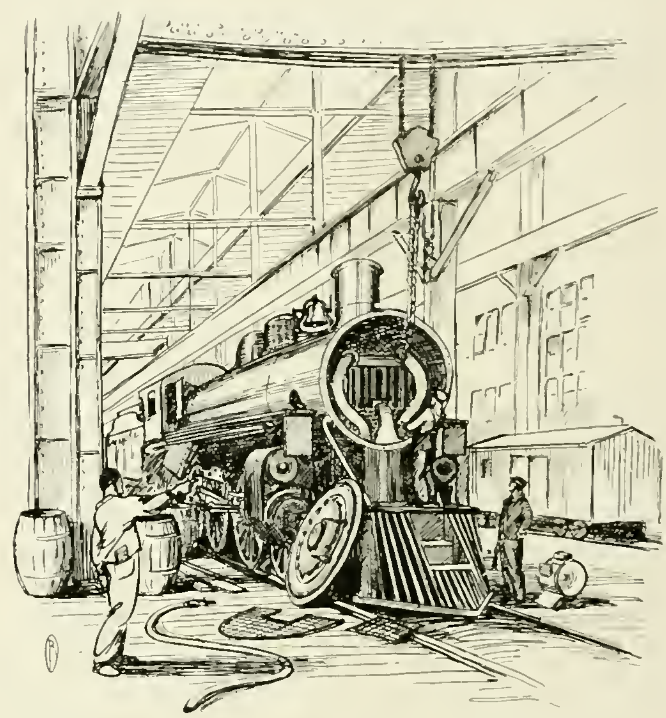
Then he began going over the work sheets. He picked out scores of places where new material should have been used but on account of none being in stock, other engines were robbed or expensive reclaiming was followed.

At one time a consolidation engine required a left steam pipe. An engine waiting shop had been robbed for a pipe although its front end required but minor repairs. The front end and netting were removed. The petticoat pipe was disconnected and the steam pipe joints broken for the sake of this pipe needed for the engine going out. It required over $100 worth of labor to apply the new pipe which would not have been removed if material had been in stock.

Gibbons groaned as he remembered disconnecting crossheads and pulling down guides for back cylinder heads from good engines, in order to rush back shop repairs. In the majority of cases, the store shortage had cost him hundreds of dollars.

He had made forgings that cost many days work for the lack of castings. He got together the figures representing wasted labor looking over the scrap pile. He then added the cost of reclaiming. Gradually his data disclosed the fact that the engine which cost approximately $2,000 for repairs could have been repaired for $1,000 if $400 had been used for material instead of $200. To get the other $200 worth of material he had spent over a thousand dollars in labor.

It seemed incredible. Gibbons knew that this was a heavy



They Had to Rob an Engine to Get a Left Steam Pipe

repair but his light repairs brought out the same approximate proportion.

All excitement the general foreman started his letter to the general manager. It was a long hand affair with a mass of figures taken from the official report. In it were typical illustrations—in other words, actual evidence. At the end of the article the foreman wrote as follows:

"Mr. Corey, if you went to a shoe store and asked for a pair of shoes, what would you think if the clerk said: 'We are entirely out of shoes, but we have some nice leather boots. They cost twice as much but they are your size. You can cut the tops off and throw the unused parts away. Otherwise, I guess you must go without unless I wire for some and I know you can't wait!' Now this is the fix the mechanical department is in, Mr. Corey. We must butcher up good stock or do without. Years ago material was cheaper than labor, but today the reverse holds true. I do not believe in waste, but unless you get your store figures up to 40 per cent of your figures of repair there is going to be a big waste in spite of the best care along lines of supervision."

The foreman signed his letter with a sprawling William Gibbons and then added his title. He then re-read the article in the magazine. It said to send the article direct to the general manager. Gibbons inserted the letter in a railroad envelope. He pulled on his shoes and started for the drug store for a stamp. The boss did not intend to have his information side tracked by going through the railroad mail.

"Ten and ninety, eh, instead of forty and sixty? Somebody's going to get their eyes opened. If they open right I get my suit of clothes—and if they open wrong I guess I'll have to look for another job." With these words on his lips William Gibbons went to sleep.

Gibbons slept late the next morning and his better half did not have time to question him. By evening she had forgotten the whole affair. Not so with Bill. All day long vague misgivings seized him. Had he done right in pursuing this course? Collings, the purchasing agent, stood very close to the general manager. It had often been said that the man who forced an issue with Collings was bound to get it, using a shop phrase, "in the neck." The day went by without a hitch, however, and the shop superintendent and master mechanic seemed unusually cheerful.

Next day trouble appeared on the horizon—about noon to be exact. The shop efficency man had got back from headquarters on the ten o'clock train and went into the master mechanic's office immediately. Then the shop superintendent was called and finally Shop Foreman Gibbons.

It was a chilly atmosphere that the shop boss struck in the master mechanic's office. He was asked to be seated and the inquisition was on.

"William," began the master mechanic. "Gordon has just come from the superintendent of motive power, and he tells us strange things. The big boss told him that the general manager, had called him up asking about a shop foreman by the name of Gibbons, who had given him some dope on savings. Wanted to know what kind of a fellow you were. Now the big boss held back on recommending you very highly until he knew what you had written, and, although all of us here have thought pretty well of you, we no doubt have been mistaken in you if you are making a practice of taking things over our head." The master mechanic gazed sternly at the shop boss as he spoke.

The efficiency man grinned at Bill's abashed face. There was no love lost between them.

"Spit her out, Bill," broke in the shop superintendent.

The general foreman hesitated a moment and then began. "Yes, I wrote him all right and told him one of the best ways of saving money around this plant."

"Why did you do that?" asked the efficiency man.

"Because he asked me to," returned Gibbons.

"Asked you to!" exclaimed the master mechanic.

Bill slowly reached in his back pocket and produced the railroad's magazine.

"Read it," he said. It was passed from man to man. None of them had noticed the article before.

"I ain't carrying anything over anyone's head," began Bill stoutly. "This was no regular railroad business."

"But you should have at least let us see it," returned the master mechanic. "Why didn't you let us read it first?"

When Gibbons was cornered he welcomed a fight. "Well, I'll tell you," he flared up, "why I didn't. Before anything like that would pass this here board of censorship there wouldn't be much left."

The efficiency man glared at the foreman's remark but the eyes of the master mechanic looked cold as ice.

"You would certainly condescend to show us a copy of the letter for the sake of the men you work for, wouldn't you?" he asked sarcastically.

Gibbons shook his head in the negative.

"It can't be done 'cause I wrote it longhand and never saved a copy."

"Then kindly tell us what you said," demanded the master mechanic.

Gibbons gave a detailed account of the letter. The jaws of his listeners dropped at the freedom of expression.

"Did you tell him all that?" gasped the shop superintendent.

"Yes, and maybe some more," returned the general foreman. "It's the truth, ain't it?"

For several moments the master mechanic sat and stared at Bill. Could this be his easy-going foreman?

"Gibbons," he finally announced, "you have got more gall than a young hogger. You should have realized that the general manager published this article to excite an interest and a spirit of co-operation; and here you unload a stick of dynamite. Of course, I can see why you sent your article in direct, but you have given us but very little protection, and if the worst comes why we simply can't save you."

"Collings, the purchasing agent, has been a thorn in our flesh and also the boss's for a long time, but he stands so close to the general manager that no one has dared to produce the facts. Now re-write the thing out to the best of your memory and shoot it up here for typing, and hurry."

Obediently Gibbons arose and left the room. In silence the three remaining men stared at each other. "I'm afraid he's in bad," absently remarked the master mechanic, "even if he did tell the truth but—but Lord what gall!" he added.

The general foreman's second letter was turned in—a copy was hurried to the superintendent of motive power. The rest of the day went badly for the poor fellow. Every thing seemed to go wrong. He received vacant stares from his bosses. "Just about as welcome as a head full of bugs," he mournfully remarked to himself.

His wife sensed his depression as soon as he arrived home that night. He confided his troubles and finished by saying:

"I'm in bad, Peggy—the gamble wasn't worth it—I played

"I'm in Bad, Peggy."

for a suit of clothes and will probably get the bounce." All night long he dreamed of a fifty dollar bill chasing a suit of clothes, both being run down by Collings, the purchasing agent.

The morning of the next day was a repetition of the previous day's misery. That is, it was until the master mechanic got his mail. Another call came for Gibbons to report to the office. Indifferently the general foreman responded. He was callous to additional trouble. He entered the doorway. It was the same room and the same faces but the atmosphere was different. Had Gibbons been more alert he would have caught the difference.

Again he was asked to be seated. The master mechanic

was holding an opened letter in his hand with a green slip attached to it.

"Gibbons," announced the master mechanic in a stern voice but with a hidden twinkle in his eye, "I just got a copy of a letter from the general manager to the superintendent of motive power. He says some awfully nice things about you which you can read later on. Says he had been misinformed in the past and that from now on more attention would be paid to getting material, and material which the mechanical department specifies will come as specified. Speaks about details taken up later along this line and mentions that he intended writing you a letter of thanks later on."

The master mechanic was now smiling broadly. "Here is a letter from the superintendent himself. He wants to know if you can be trusted with the job of mechanical inspector. Tells me that that fellow Gibbons must have some kick in him when he dares to tell the truth."

The master mechanic's eyes fell again on the original letter. "Oh, yes, by the way, my copy from the general manager has your check for $50. You see, you got the prize. Your nerve ought to get you to the top of the ladder, my boy, and I admire your spirit, but I wouldn't get in the habit of going much higher than your next officer in passing information, because it don't pay."

The efficiency man slipped out. Bill received congratulations from the shop superintendent, and thanked the master mechanic for his words of advice.

"Honest, Mr. Good," he confessed to the master mechanic, "it wasn't nerve—I didn't know any better, and, to tell you the truth, I wanted that money for a suit of clothes."

The superintendent and his boss laughed heartily. "Better dig out early tonight, Bill, and pick 'em out," advised the superintendent. "You've done enough good around here to last for years." These were the parting words Gibbons caught as he left the office with an unconfined joy in his heart.

The two men remained sitting at the desk and watched the happy Bill swing toward the back shop doors down the lane of busy machines.

"How did he get by? Can you beat it?" remarked the superintendent of shops to his superior officer.

"Well, I first thought that it was because fools will walk where angels fear to tread, but I guess I'm wrong, because Gibbons has proved he's no fool, and I know tarnated well you and I aren't angels. Let's just say it was taking advantage of a literal interpretation and let it go at that. He's paved the way for getting us material. Got any one picked for his job after he gets his new position?"

Locomotive Repairs at Shop and Enginehouse*

Thoroughness in Back Shop and Attention to Slight Defects at Terminals Needed to Save Fuel

BY LESLIE R. PYLE
Supervisor Fuel Conservation, Central Western Region, Chicago

Locomotive maintenance is one of the vital features of railroad operation. During the past two years, locomotives all over the United States have been turned so rapidly through terminals that a great many times needed repairs have been dispensed with. So far as one can see, there is no indication of a decrease in business; therefore, now is the time to take a definite stand for a better standard of locomotive maintenance.

The writer would urge for consideration and adoption, the standardization of the best practices for each piece of work to be done. Aimless effort however diligent will not produce the results that are possible through a well-defined plan and a standard by which to gage every effort. These standards should be blue printed, each print containing written instructions describing in detail how each job should be handled. This will insure every shop or droppit doing the work in the same manner. When a better practice is developed, the print should be changed to cover the improvement. If this is conscientiously followed, every shop will be doing the work in what is known to be the best way. Improved methods and practical short cuts are always acceptable and suggestions offered by anyone in any position should have thoughtful consideration. We should encourage men in subordinate capacities to give us their ideas and such ideas, when found to be practicable, should be adopted and the employee given the credit for the improvement.

Although it is realized that enginemen can and do waste fuel with locomotives in first class condition, it is obvious that the engineer will have no control over the fuel waste due to cylinders out of round, valve gear out of square, etc. When we consider that from 85 to 90 per cent of the total railroad fuel is consumed on the locomotive, there can be no doubt about the need for careful, painstaking preparation of the locomotive, first in the shop and then in the enginehouse.

Shop Maintenance

Naturally the shop is where the foundation is laid for preparation of the locomotive which will result in fuel conservation. Usually, when the locomotive enters the shop, it is accompanied by a work report showing what work is considered to be necessary. Too often when a locomotive is received in the shop, a council is held to determine just how little work can be done. This often results in work being neglected which should have been done in the shop, where the facilities tend to reduce the cost of every operation.

At present, but four to six per cent of the total heat developed is applied to the draw-bar in the form of useful work. Anything which tends to lower the efficiency of the locomotive is taken from the four to six per cent at the draw-bar and not from the 96 per cent total heat liberated in the firebox. This is why we lay such stress on the locomotive being thoroughly overhauled in the shop.

Bearing in mind that the power developed by the locomotive is produced in the firebox through the liberation of heat generated by the fuel when it is burned, we should consider the condition of the firebox and boiler when the locomotive is sent from the shop.

The firebox should be free from all steam leaks. Flues should be well set in the sheet so that there will be no trouble from flues leaking while the engine is in service. This also applies to welded flues.

Boiler sheets and tubes should be absolutely clean and free from scale. There should be enough well located wash-out plugs to enable boiler-washers to keep the sheets

*Abstract of a paper read before the Western Railway Club, January 19, 1920.

and tubes clean through the use of properly designed wash-out nozzles.

Grates and grate bars should be in good repair with well-designed shaker levers which will make the shaking of grates under service conditions a practical operation. A locking device should be provided to hold the grates level under the fuel bed, thus preventing holes in the fire and burnt-off grate fingers.

Arch tubes should be applied to locomotives not already equipped. It should be known that the ends of the tubes are beaded or belled sufficiently to provide against any possibility of the tube pulling through the sheet. These tubes should be thoroughly cleaned if dirty when reaching the shop.

The front end draft appliances should be installed according to a definite standard which has been arrived at as the result of road tests. These tests should have developed the practical setting for the petticoat pipe if one is used, the draft plate and the size of the nozzle tip, to insure a free steaming locomotive burning the average quality of fuel used. Blue prints should be furnished all shops and roundhouses, showing the standard front end setting and size of nozzle tip for each class of locomotive. Front end appliances should be set according to this print when engines are turned out of the shop.

The petticoat pipe should be well supported on hangers which hold it in a direct line with the smoke stack to insure the exhaust jet passing through the center of the stack. The joints between the base of the nozzle stand and cylinder saddle, and between the nozzle tip and the top of the stand, should be perfectly tight. Steam leaks at these joints materially affect the steaming qualities of a locomotive.

Steam pipe joints should be thoroughly ground in, insuring no leaks here.

The superheater should be applied according to blueprints furnished either by the superheater company or by the railroad company. If these prints are followed, no other directions should be necessary.

It is important that the joints of the superheater elements be thoroughly ground in. Heat treated bolts of high tensile strength and elastic limit should be used to bring the joints to a seat and hold them there. Suitable bands and bridges should be used to keep the elements from moving in the flues and to hold them up, making it possible to blow soot and cinders from beneath the elements. The damper should be applied in such a way that the correct opening will be obtainable and be securely fastened to the damper shaft to insure its positive operation.

If the stack or cylinders are changed while the locomotive is in the shop, the whole machine should be leveled up and the center of the nozzle tip plumbed with the center of the stack to insure the exhaust jet passing through the center of the stack. This should be emphasized because it is a common thing to find the exhaust jet out of line with the center of the stack.

Before the locomotive leaves the shop, a hydrostatic test should be applied, making a final inspection of all joints in the smoke box, a cap being placed over the nozzle tip when making the test. This may appear to be useless work, but it has been a common occurrence to find engines just out of the shop with steam leaks in the front end.

With draft appliances well arranged to provide draft through the boiler and the firebox, it becomes necessary to go below the mud ring to insure an adequate opening in the ash pan which will admit sufficient air to burn the maximum amount of fuel consumed under any working conditions. This should be an opening which will not clog up with cinders or with snow and ice in cold weather. An opening which is covered with netting is not satisfactory as it is too easily stopped up. There are a great many locomotives in service today lacking sufficient area of opening through the pan to admit air enough for complete combustion under normal conditions. Knowing this, we earnestly recommend that all locomotives be provided with the necessary amount of opening through the pan. This may involve radical changes in pan construction but the results obtained from such changes justify the expense.

Steam is used primarily to haul the train. Circular No. 19 sent out by the Fuel Conservation Section, illustrates in a striking way, the loss of fuel due to defective steam distribution. This circular brings out the fact that from 9.4 to 18.4 per cent of the steam was wasted due to distorted valve gear.

While the engine is in the shop, all pins and bushings in the valve gear should be renewed if they are worn at all. This brings to mind a statement of a roundhouse foreman in reply to a question asking why he was allowing a switch engine to remain at work when it was noticeably lame. He replied that the valves were only a little bit out. There is no little thing when considering the setting of valves and the elimination of lost motion through worn pins and bushings.

There should be a definite standard of valve setting for each class of locomotive. Valves should be set according to this standard before leaving the shop. If this is done carefully and all lost motion removed from the valve gear through the elimination of worn parts, we have made a good start towards the economical use of steam.

In the shop, if the wear in the cylinders is 1/16 in. or greater, they should be re-bored. Packing rings should be supplied which have been turned to compensate for the material taken out of the cylinders. If the valve bushing is worn 1/32 in. near the bridges, it should be re-bored and the necessary rings supplied.

A good plan to insure packing rings of the proper size is to have a definite standard of boring practice, a specified amount being taken out of the bushing each time it is bored and the cylinder packing rings turned and marked to correspond with the mark on the bored bushing. If this plan is followed, packing rings can be kept in stock to compensate for the bored bushing.

After taking care of the valves and cylinders, we should give the engineer every assistance in using the right cut-off while running the engine by putting the reverse lever and reach-rod up in such a manner that they can easily be handled. We can all recall locomotives which have been sent out of the shop with the reverse lever and reach-rod in such a condition that it required both the engineer and the fireman to handle the lever. This does not lead to co-operation from the man who has to operate the locomotive.

The power reverse gear should be overhauled at the same time the engine is. Reverse gears of this type should be as good as new when leaving the shop. There has been a great fuel waste through power reverse gears creeping and it has been found due to leaks in the operating mechanism, worn parts, allowing lost motion to develop, or through poor or worn packing.

Air compressors should be in good repair when placed upon the locomotive in the shop. All piping connected with brake equipment on the locomotive should be put up in such a manner that there are no air leaks. It has been found by tests that leakage as high as 15 lbs. per minute existed on the engine alone.

Steam used by auxiliary equipment amounts to six per cent of the total heat developed. This is why we stress the maintenance of such equipment as mechanical firedoors, bell ringers, headlight dynamos, steam grate shakers, cylinder cock operators, etc. All auxiliary equipment should be overhauled and tested in the shop to insure the maximum of good service from all devices. Headlight dynamos should

be well taken care of and all valves to the dynamo in good repair, making it practicable to close them to prevent leakage of steam.

Devices or valves which have to be operated by engineers and firemen should be, wherever possible, within easy reach of them to insure the efficient operation of the device. When men have to go out of their way to reach valves, the full value of the device is not always obtained.

Hot boxes waste more fuel than people generally realize. If a locomotive is delayed 30 minutes with a hot bearing on a busy piece of track, this delay is not confined to the one train and engine, but is passed on to numerous trains behind, the loss being cumulative. Special attention should be paid to the fitting of brasses and weight distribution on the axles to prevent hot boxes on locomotives.

Radiation losses on a locomotive amount to approximately five per cent of the total fuel consumed. A large portion of this loss may be prevented by thorough insulation. It is recommended that all steam pipes to air pumps, injectors, etc., be insulated with asbestoc from 1/4 in. to 1/2 in. thick, depending upon the amount of room around the pipe then covered with asbestos canvas, which in turn is covered with retort cement, thus making a weather and heat proof job. This applies to steam piping in the cab.

There is about 50 sq. ft. of uninsulated surface around the water legs of nearly all locomotives, which could be insulated with very little trouble to assist in preventing some of the per cent loss in radiation.

Stoker equipment should receive thorough attention while in the shop. One particular part of the stoker equipment which has caused considerable waste of fuel is the conveyor trough underneath the deck. When the conveyor is working, coal is pushed over the top of this trough and thrown on the ground. Inspection develops that this condition still exists and it should be eliminated.

An apparently simple matter but one which causes a waste of fuel, is the condition of the deck around the grate levers. It is common to find large holes around these levers through which coal is constantly lost while the engine is in service. In the first place, such holes should not be cut in the deck, but if they do exist, they should be covered with strips of metal.

Where the air pump exhaust is tapped into the smoke arch and goes out through the smoke stack, this connection should be changed to the exhaust passage in the saddle. There are two reasons for this: one is, that the exhaust passing through the front end creates a draft on the fire which cannot be controlled by the engineman and wastes considerable fuel; the other is, that as the air pump is usually working more or less, the exhaust from the pump will assist in relieving a vacuum in the exhaust passage when the throttle is closed and the train moving, which in turn reduces the amount of soot and gases drawn from the front end into the cylinders.

It will be impossible to touch on the general overhauling of the locomotive, but the parts and devices mentioned have been dwelt on because they have a direct influence on fuel consumption. It is true that they can be neglected and the engine will get over the road, hauling the train and apparently none the worse for the neglect. While it may not be visible in the operation of the locomotive, lack of repairs to these parts does waste fuel. As this waste is preventable and is no doubt many times greater than the cost of making repairs, we do not hesitate to recommend that such repairs be made.

It is easier to win when you are in the lead than to catch up when you get behind. The habit of starting early and starting right is not acquired by any sudden resolve. It must be built by careful practice and steady training—by conscientious study with the application of the best rules and regulations. Plan your work, then work your plan, making every play and every day a definite advance toward the goal, which should be 100 per cent locomotives.

Roundhouse Maintenance

In considering roundhouse maintenance, we must assume that the officer responsible for locomotive maintenance is allowed sufficient time to make necessary repairs. On nearly all railroads, the transportation officer often requires the turning of the power so rapidly that locomotives do not receive needful repairs. One superintendent told at a division fuel meeting that he was running his engines until the stack fell off and the bell rolled over into the field. In starting engines out in this condition, he realized that they were not fit to go but gambled that they might make a successful trip. His testimony was that he often had to send a second engine to get the first one in.

Sooner or later, locomotives have to be repaired, and under the present operating conditions we cannot look forward to a slump in business which will make it possible to hold power in the roundhouse long enough to do work on them which has accumulated. If the mechanical officer is successfully to maintain the locomotive in condition for economical and successful service, "the stitch in time" rule must be put into effect. This means that repairs have to be made as the need for them develops. He should be the judge of when a locomotive is fit to leave a roundhouse ready to make a successful trip. Often locomotives are hurried out and fail, necessitating the use of a second engine which many times has to give up a train of inferior class to take a superior train to a terminal. Such practices cause delays and congestion on the railroad and could be avoided generally if locomotives received necessary repairs.

As in the shop, we will consider the maintenance of the boiler and firebox as the first consideration. The boiler should be kept clean by frequent and thorough washings, preferably with hot water. It is generally accepted that hot water wash-out plants materially reduce the time required to wash boilers and by using waste steam to heat the water used for washing and filling, a direct fuel saving is accomplished.

It is important that sufficient pressure be used, with nozzles so designed that the water will reach all parts of the boiler. With well located wash-out plugs, it will then be possible to thoroughly clean the boiler at each wash-out. This, of course, implies that where water contains scale-forming elements, some form of water treatment be used.

In a paper by A. N. Willsie, read at the International Railway Fuel Association meeting, May 15, 1916, he shows a table giving the loss of heating power due to scale as follows:

"There seems to be a variance of opinion as to the losses due to the accumulation of scale in boilers. Some of the best authorities give the losses as about as shown in the following table:

Approximate Loss of Heating Power Due to Scale

Thickness of scale, in.	1/64	1/32	1/16	1/8	3/16	1/4	3/8	1/2	5/8	3/4
Per cent loss of heating power	2	4	9	18	27	38	48	60	74	90

"These figures are not considered absolutely accurate as these losses are not found to occur in all boilers because the whole of the boiler surface does not usually become covered; still the loss is always serious, apart from the stresses set up in the boiler plates.

"The test made by Mr. Breckenridge of the University of Illinois, on a Mogul freight engine, which had been in service for 21 months, is recorded in the *Railroad Gazette*, January 27, 1899, page 60. This engine was tested, then sent to the shops and new flues installed, then tested the same as before. In order to get the average thickness of

scale, it was entirely removed from the tubes and weighed. This thickness gave an average of 3/64 in. on the principal heating surface and the loss in heating power due to the scale was 9.55 per cent."

It is evident that there is a decided loss in heat transmission when boiler sheets are allowed to accumulate a scale deposit. Water treatment and thorough boiler washing will practically eliminate scale from locomotive boilers in any kind of water. When boilers are kept clean it is comparatively easy to maintain the flues free from leaks.

There should be an inspection of the flues each trip and where necessary, they should be calked, or expanded and calked, depending upon the practice standardized on each railroad. Where flues are welded in, welding outfits should be maintained at terminals so that when the welds break, they can be re-welded. Firebox leaks, even though they do not cause failures, waste fuel, and where locomotives are allowed to run with flues in a condition that causes failures or near-failures, an excessive amount of fuel is consumed per trip. Flues which will not permit a successful trip should be changed.

Grates should be renewed when fingers are broken or burnt off and grate bars should be well maintained, insuring a perfect support for the grate sections. Grates should shake freely. To make this possible, grate levers and rods should be kept in good working condition. Grate fingers should not bind. Any neglect in the maintenance of any part of the grates or shaking apparatus tends to discourage the intelligent use of grates by engine crews and on this account should be thoroughly maintained. Steam grate shakers should be kept free from steam leaks at all joints in the piping and the grates otherwise maintained the same as with manually operated grates.

Frequent inspections should be made in the front end. The front end inspector should have someone on the outside open and close the superheater damper and actually see that the damper opens full width, not moving on the damper shaft. Where engines are equipped with petticoat pipes, the pipes should be renewed when worn and set to insure exhaust jet going out the center of the stack. Inspection should show that the locomotive still has the standard size nozzle with which it came from the shop.

When reports are made that the engine does not steam, do not make any change in the draft appliances. The steam pipes should be subjected to a hydrostatic test to determine whether there are any leaks in the superheater elements or return bends, steam pipes, at the base of nozzle stand, or at the base of the nozzle tip. If everything is tight and set to the adopted standard, someone should ride the engine to locate the trouble. Find the real trouble; do not change appliances or reduce the nozzle, except for weather or special fuel conditions.

It should be known by inspection that flues, both on superheated and non-superheated locomotives are kept clean. Nearly all roads have flue cleaning organizations but it has been found necessary to check up the work of these men to insure their doing it thoroughly. The Fuel Conservation Section has issued circulars showing the loss in fuel due to stopping up of large flues on superheated locomotives. This loss varies as shown on the following table from Circular 16:

Number of superheater flues stopped up.	Average temperature of steam (deg. F.)	Drop in temperature below 586 deg. F. (deg. F.)	Superheat (deg. F.)	Fuel loss (per cent.)
None	586	..	211	.....
5 to 7	576	10	201	0.04 to 2.6
8 and 9	549	37	174	6.0 to 9.6
12	517	69	142	13.2 to 14.6
18	491	95	116	21.0 to 24.2

If, for any reason, valves become out of square through lost motion in the valve gear or accident, they should be squared up immediately.

Cylinder and valve rings should be renewed when necessary to prevent blows, which are exceedingly wasteful of steam and materially affect the hauling power of the locomotive. Many roads have adopted a 30-day inspection of cylinder and valve rings. Such inspection develops many worn rings which would not be reported. This practice is recommended for consideration by roads not doing it. If an engine has been out of the shop for a long time and the cylinders have become worn 1/8 in. or more, they should be re-bored and fitted with packing rings turned to fit the re-bored cylinders, such rings being maintained in stock.

Hot-box reports should receive prompt attention. If a locomotive is equipped for the use of water on hot bearings developed en route, it should be known that there is no stoppage in the line of water travel to insure an available supply when the need arises. Water cooling equipment on locomotives should not in any way relieve the roundhouse from prompt attention to defects causing hot bearings.

A habit has prevailed to some extent which has been expensive wherever practiced. That is, allowing locomotives due for the shopping in two or three months to run with valves out of square, with clyinders blowing, leaky flues, or some defect which materially affects the successful operation of the locomotive. The money wasted due to not making repairs which would have permitted the economical and successful operation of the locomotive, would have been saved many times over while the engine was waiting to go to the shop.

All auxiliary devices, such as bell ringers, headlight dynamos, firedoors, steam grate shakers, power reverse gear, etc., should be kept in good repair. Many of them are put on the locomotive to increase the economy of locomotive operation and unless they are maintained, the effect is just the opposite.

No lost motion in power reverse gear levers and connections should be allowed and no air leaks in the piping should exist. If these two things are taken care of and the packing is well maintained, there should be little trouble from reverse gears creeping. Usually, the engineer is relieved from oiling the reverse gear and oftentimes this is neglected in the roundhouse, resulting in a dry piston, which means a slow acting gear.

Where flange oilers are used, the nozzle which feeds the oil to the flange should be in alinement with the flange and kept securely fastened there so that the oil will be deposited on the flange and not on the tread of the rail. A heavy, sticky oil should be used for flange oilers in preference to the lighter crude oils. This gives a longer wearing lubricant, materially assisting in the reduction of rail wear in addition to reduced flange wear.

Injectors should be maintained so that they will go to work without excessive attention on the part of the engine crew. One of the most annoying features with which enginemen have to contend is an injector which will not go to work unless fussed with for some time. This causes unnecessary safety valve operation and oftentimes an actual neglect of the fire, all contributing to a direct fuel waste.

Firedoors of the manually operated type should be evenly balanced, insuring ease of operation, equipped with a good latch on the door to hold it open when the track is rough or in going around curves. It is impossible to fire well if the door closes while the fire is being put in. The chain should be hung so that the firemen can reach it and open the door with a minimum of effort. In fact, he should be able to open the door and close it between each scoopful of coal fired, hardly knowing that the door is there.

Safety valves should be coordinated with the steam gage so that the blow-back should not be more than three or four pounds.

The apron between the deck of the locomotive and the

shovel sheet should be level. An apron which is curved or bent in any manner makes it difficult for the fireman to stand securely while firing. To enable the fireman to practice skillful firing, there should be no hindrance to a full, easy play of the muscles. Bent or curved aprons and roughed shovel sheets hamper the smooth work of a fireman materially. The shovel sheet should be level and free from any obstructions which will interfere with the movement of the shovel over the sheet and should extend back far enough into the coal to allow the fireman to get practically all of the coal out of the pit. A coal guard should be placed in the right gangway to prevent coal from being pushed out.

Brick arches should be maintained as shown by standard instructions.

Steam leaks around the locomotive are not only a Federal defect but are wasteful of steam.

The air brake system on the locomotive should be maintained free from leaks, and the compressor should be in as near 100 per cent condition as possible. The loss in time necessary to charge trains with the accompanying loss in fuel through steam consumed when the compressor is in poor condition is illustrated by the accompanying table from Mr. Willsie's paper, mentioned previously:

"The actual number of cubic feet of free air compressed to 100 lb. per minute pressure with 200 lb. steam by several compressors is as follows:

Compressor	100 per cent condition	75 per cent condition
9½-in.	44 cu. ft.	33 cu. ft.
11 -in.	66.5 cu. ft.	50 cu. ft.
8½-in. C. C.	131 cu. ft.	97.5 cu. ft.

"The 100 per cent condition referred to is the capacity of the air end of the compressor when in perfect condition, and is necessarily considerably less than the actual displacement of the compressor air piston.

"The 75 per cent condition referred to is the minimum condition permissible under the Interstate Commerce Commission ruling, and relates to the 100 per cent condition first mentioned."

It is necessary to use a drifting throttle on superheated locomotives to insure good lubrication. If a drifting throttle is to be used, we should provide the engineer with a throttle that will stay set in any position desired. Many throttles of necessity are shut off entirely or are nearly wide open and the engineer has to use a stick or try and hold the throttle in a drifting position, which is practically out of the question.

Engineers must be encouraged to make out the necessary reports for the guidance of the roundhouse foremen in maintaining the locomotive. A locomotive inspector, preferably an engineer, who would meet incoming engines while the crews are still on them, talk with the crew about the locomotive performance, help them make necessary tests to determine blows, etc., assist the engineer in making out his report, possibly making out a separate one, and then check the work done on the locomotive when it comes out of the roundhouse, can be of untold value to any mechanical organization, as these men not only uncover many defects but help educate the engineer to make out intelligent work reports, saving the mechanics considerable time in hunting for defects.

Terminal Handling

After the actual mechanical work of preparing the engine for service has been finished, we are going to assume that the transportation officer is cooperating with the mechanical officer, making it feasible to place a definite order for the locomotive for a certain time. Definite printed instructions should be posted in every roundhouse showing just how far in advance of leaving time, each class of power should be fired up and just how the fire should be built. The fire builders should follow this line-up.

To prevent pops opening in firing up, the blower should be shut off before the maximum steam pressure has been reached. This, of course, implies that the instructions to the fire builder provide against any heavy firing which would have built up too heavy a fire before leaving time.

When air brake men come around to test the air pump and brakes, they should not put more coal in the firebox and run the pressure up to the maximum, going away and leaving the pops blowing indefinitely.

Too many times when the fire is built an excessive amount of water is put into the boiler. When the engine is taken out of the house and placed on the storage track so full of water that it is impossible to work the injector any more, there is bound to be an excessive operation of the safety valves. When the engine crew arrive and the boiler is full, it is impossible for the fireman to build up the right kind of fire without the loss of a great deal of fuel through the safety valves. The boiler should be filled with sufficient water to prevent any danger of low water before steam pressure enough is obtained to work the injectors. The fire should be built up gradually, using just enough fuel to raise the temperature high enough to make all necessary tests before the engine goes into service.

From 20 to 30 per cent of the total fuel consumed by the locomotive is used around terminals, and there is room for real economy in the building of fires, if it is systematically supervised.

After the fire is built and the engine taken out of the house, just enough fire should be maintained to keep water enough in the boiler to provide against low water. With the boiler supplied in this manner, it is possible for the fireman to build up a fire of the right depth without excessive popping.

Hostlers should be taught by demonstration the way the fire should look when the engine is taken out of the roundhouse and inspection should be made of every fire before taking the engine out of the house. When poor fires are being built a report should be made to the roundhouse fireman to prevent a continuance of such practice. Lack of attention to fire building, resulting in poor fires being turned out of the roundhouse, has been responsible for many delays due to cleaning fires between terminals.

Cylinder cocks should always be opened and the engine started slowly when being taken out of the house or moved around the terminal by the engine watchman or hostlers. The cylinders nearly always contain water, and unless the cylinder cocks are open and the engine moved slowly, this water is worked directly through the cylinder and out through the stack. The writer is of the opinion that a great many of our cylinder leaks are caused by working water through the cylinders around terminals.

When engines are placed on the outgoing track, all tools and oil cans should be on the engine in good condition so that the crew will not have to run around looking for supplies, which takes time away from their regular duty of preparing the locomotive. Incoming locomotives should be dispatched with the greatest possible speed to insure all of the time possible in the roundhouse for necessary work. If the roundhouse is too small to handle the business, it is better to take out the engine which has been repaired and make room for an incoming engine needing repairs than to keep the incoming engine outside for several hours and then, when it is in the house, have to turn it out again without having time to do the necessary work.

Many different local conditions handicap thorough mechanical repairs. I remember an instance last winter on a certain railroad where we found the superintendent and master mechanic cleaning fires on the cinder pit to assist in moving power through the terminal. It is obvious that many things which have been suggested in this paper will be lost sight of under such conditions, but we must have high ideals or our general practice will be of a low standard.

NEW DEVICES

A 14-INCH GEARED HEAD LATHE WITH COMPACT MOTOR DRIVE

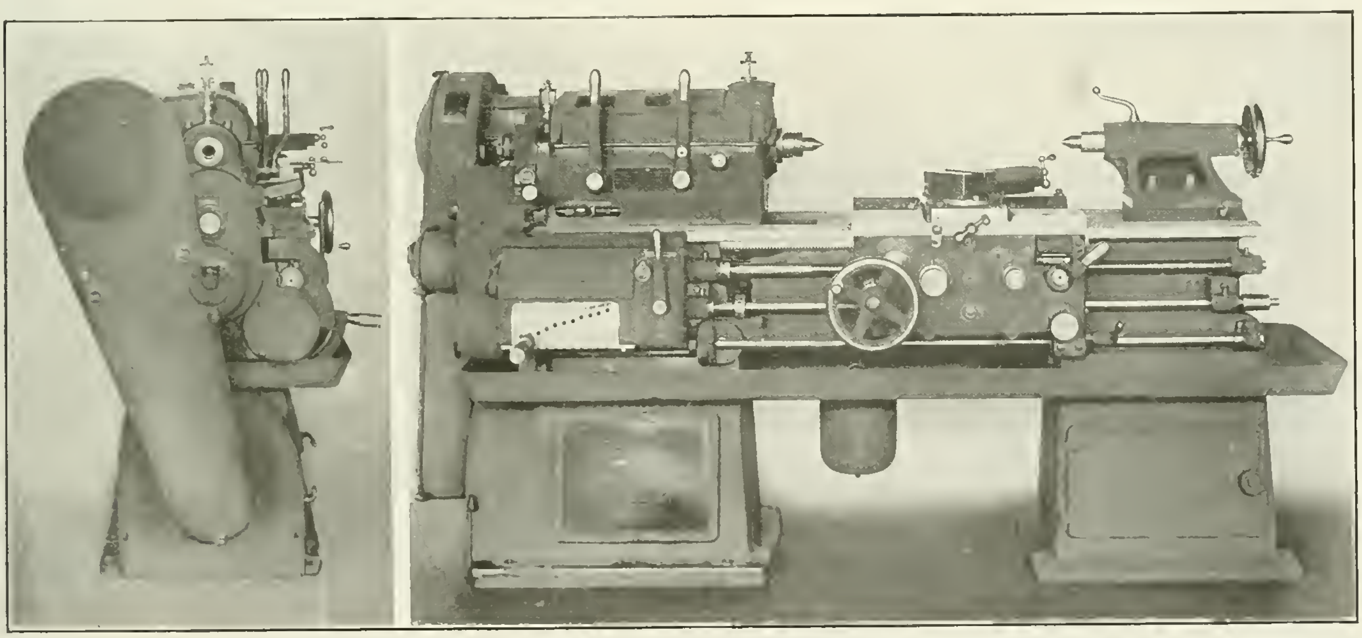
A new 14-in. geared head lathe with a compact arrangement for motor drive has been placed on the market by the Reed-Prentice Company, Worcester, Mass. It is a well balanced machine and the distribution of metal is apportioned to absorb vibration under heavy cutting feeds and speeds. In casting the various units an equal thickness of walls was maintained so that when cooling undue internal strains would not develop, and distort the machine after delivery.

The lathe headstock is of the selective type, permitting the operator to obtain any one of eight speeds without slowing down the machine or removing the cutting tool from the work. It is stated that the change from one speed to another cannot be detected on the work even should such a change be made while the tool is taking a cut. The speeds are obtained by the use of spur gears which are constantly in mesh the full width of face and depth of tooth. The internal expanding friction clutches are of special patented design. It is impossible to engage conflicting ratios of gears as the spindle will not start until the three levers are in operative position. Therefore, any one of the levers when brought to a neutral position will at once stop the spindle. The spindle bearings are hardened and ground. The journal boxes are of bronze, scraped to the spindle to insure correct alinement and maximum bearing surface.

The back gears, spindle and pulley shaft have been brought up to the same plane which makes them much more accessible and permits the gears to run in an oil bath. The intermediate bevel gear in the reversing attachment being brought up to a plane with the pulley shaft, permits more rigid construction of the shipper mechanism and a more accessible arrangement for adjusting the friction fingers when necessary.

In order to remove the face plate from the spindle nose, a locking mechanism has been introduced in the form of a plunger which engages the hardened steel notched ring, keyed directly to the spindle. This prevents the rotation of the spindle and permits the removal of the face plate without transmitting any strain to the gear teeth. To insure against starting the spindle while this plunger mechanism is in operation, a locking mechanism has been introduced which prevents the engagement of the spindle clutch until the plunger has been removed. In case the clutch is engaged, the locking mechanism also keeps the plunger set at neutral position.

A geared pump in the headstock supplies the lubricating oil for all of its bearings, with the exception of the two main spindle bearings, which are supplied from sight feed oilers as shown. Ball bearings of the Gurney type are used in the drive pulley, which eliminates most of the friction due to belt tension. The rocker carrying the tumbler gears at the end of the head is of new design, being a pull plunger with locating holes in the side of the head. The spindle is reversed by means of bevel gears and shafts in preference to the old link motion. The control handle for the stop, start and reverse is located at the right hand lower corner of the apron and is therefore at all times in a convenient position for the operator. The quick change gear of this lathe has also been modified to make the entire unit more accessible and rigid.

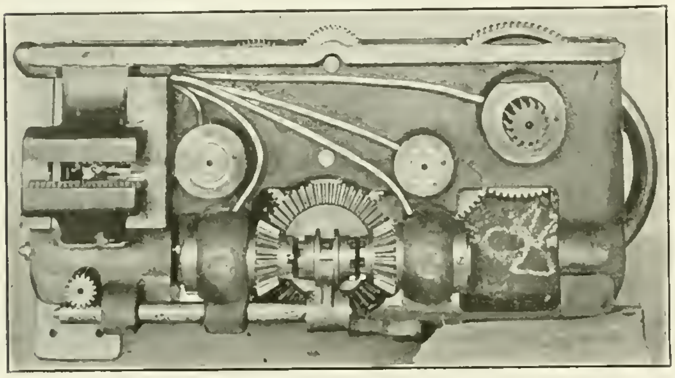


Reed-Prentice 14 In. Geared Head Lathe with Driving Motor Located Inside the Cabinet Leg

The carriage apron is of double plate construction, which permits easy access to the internal mechanism without removing the carriage from the bed. The shafts and studs are sup-

ported at both ends in bronze bearings. The rear plate is made in box form securely bolted to the carriage. The open-and-shut nut works in guides which are cast integral with the rear plate. A new locking mechanism, simple and rigid in construction has been incorporated to prevent the engagement of the longitudinal feed when the open-and-shut nut is engaged and vice-versa. An oil reservoir with protecting dust cap is placed at the upper right hand corner of the apron for lubricating all of the bearings in the rear plate. The front bearings are lubricated by oilers provided at each bearing.

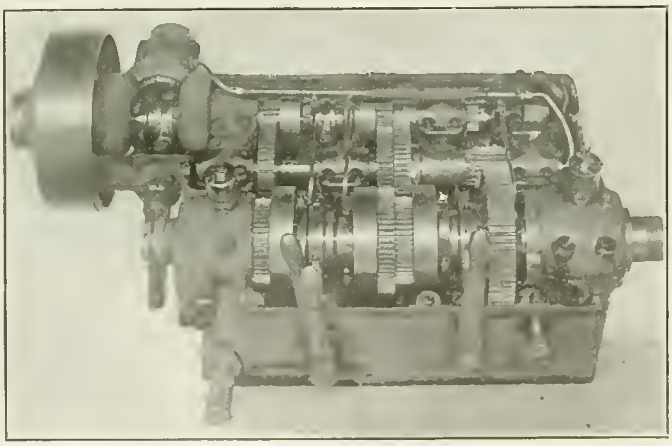
The carriage has an exceptionally large area over the



Rear View of Apron Showing Double Plate Construction and Feed Bevel Gear Arrangement

sliding surfaces on the vees of the bed. The bridge does not extend by the front horns, this being overcome by widening the apron seat. The tailstock has been strengthened and made more rigid by widening the base and giving it a better support on the inside vees of the bed. The additional vee in the tailstock has a reinforcing effect on the bed, acting as a clamping device wherever the tailstock is located.

The bed has been not only widened and deepened considerably, but reinforced throughout by increasing the metal thickness and spacing the heavy ties much closer together. The top of the bed is of the drop vee type, the inside vees



Back Gears, Pulley Shaft and Spindle are all in the Same Plane

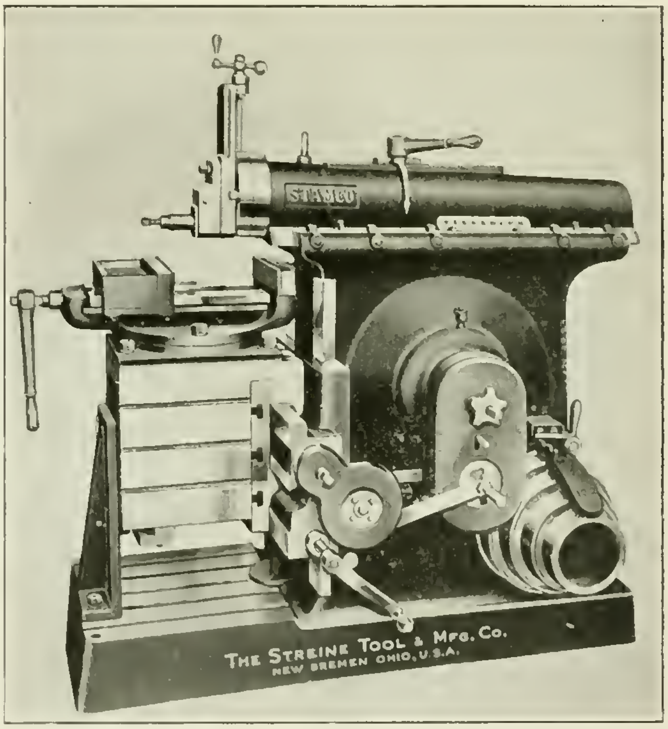
being lower than the outside, thereby preventing any excessive cut in the bridge of the carriage.

Slight improvements have been added to the taper attachment, particularly in the method of guiding the traveling shoe on the taper bar. There has always been a tendency of the shoe to lift from the bar when under pressure, which had a slight effect on the work. This has been eliminated by the introduction of a gib engaging a ledge planed the entire length of the taper bar. Graduated dials, reading in the thousandths of an inch, are made a part of the rest screw. When the lathe is belt driven directly from the main line or countershaft, standard cabinet legs are used, having doors in the front so that the space inside may be utilized for storage purposes. The steel oil pan with oil reservoir pump and piping are furnished when ordered.

Two types of motor drive can be furnished. In the one illustrated the motor is mounted inside the head-end cabinet leg and connected to the head drive shaft by a carefully guarded belt or silent chain. This arrangement is compact, protects the motor and eliminates the overhang of motor or pulleys. The second method of motor drive is through rawhide spur gears with the motor mounted on a bracket at the rear of the machine. The bracket is bolted to a pad cast integral with the head end cabinet leg.

HEAVY DUTY CRANK SHAPER

A 16-in. heavy duty back geared crank shaper has been developed recently by the Streine Tool & Manufacturing Company, New Bremen, Ohio. The base of this shaper is of the extended type, unusually deep and affords a solid foundation for the machine. T-slots in the large planed



Stamco 16-In. Heavy Duty Shaper of the Extended Type

surface run back to the column, as shown in the illustration, and provide for setting up large pieces of work. The rigid construction of the machine throughout renders it suitable for the heavy work usually found in railway machine shops.

The column is of unusual depth and width at the base, thus making a more rigid joint between the base and the column, and at the same time lowering the center of gravity. The bull gear bearing is cast solid in the frame, which eliminates considerable wear caused by springing and friction. The bull gear itself is supported close to the rim by the frame which does away with the tendency for it to bind or break away from the hub. The total area of the bull gear bearing is 205 sq. in.

The crank block and its adjusting mechanism are set into the bull gear, thus reducing the overhang between the rocker arm and the gear to a minimum. The bull gear construction and its relation to the rocker arm, as mentioned above, eliminates practically all vibration and chatter, without making the working parts too heavy and cumbersome.

The bull pinion rotates on bronze bushings as in the

usual planer construction, and the intermediate gears are mounted on extended hubs of the pinion. The driving gears are mounted on a long sleeve, which slides on a key in the pulley shaft. The gear ratio is arranged so that the speeds of the ram are in geometric progression and there are no conflicting gear ratios as in some forms of pinion gear drive. The pulley rotates in a sleeve bearing bolted to the column, thus relieving the shaft of belt pull and eliminating an extra bearing. An unusually long ram bearing is provided, which insures accuracy and reduces wear to a minimum. The rail is clamped to a dove-tail slide on the column, insuring accuracy in any position. The saddle fits into a narrow guide on the rail, which provides large wearing surfaces and equalizes the strain on the rail screw. The position of the table is controlled by means of a telescopic elevating screw, which is provided with a ball thrust bearing. The table can be removed, as previously stated, and large work bolted to the saddle or base.

Arrangement is made to vary or reverse the feed while the machine is in motion, and the feed can be set at any desired amount quickly. Owing to the absence of adjustable or friction links the feed is constant at any position of the rail. The adjusting screws are provided with micromoter collars, graduated to .001 in. and all adjustments are within easy reach of the operator. The head and the vise are graduated in degrees and can be set to any angle.

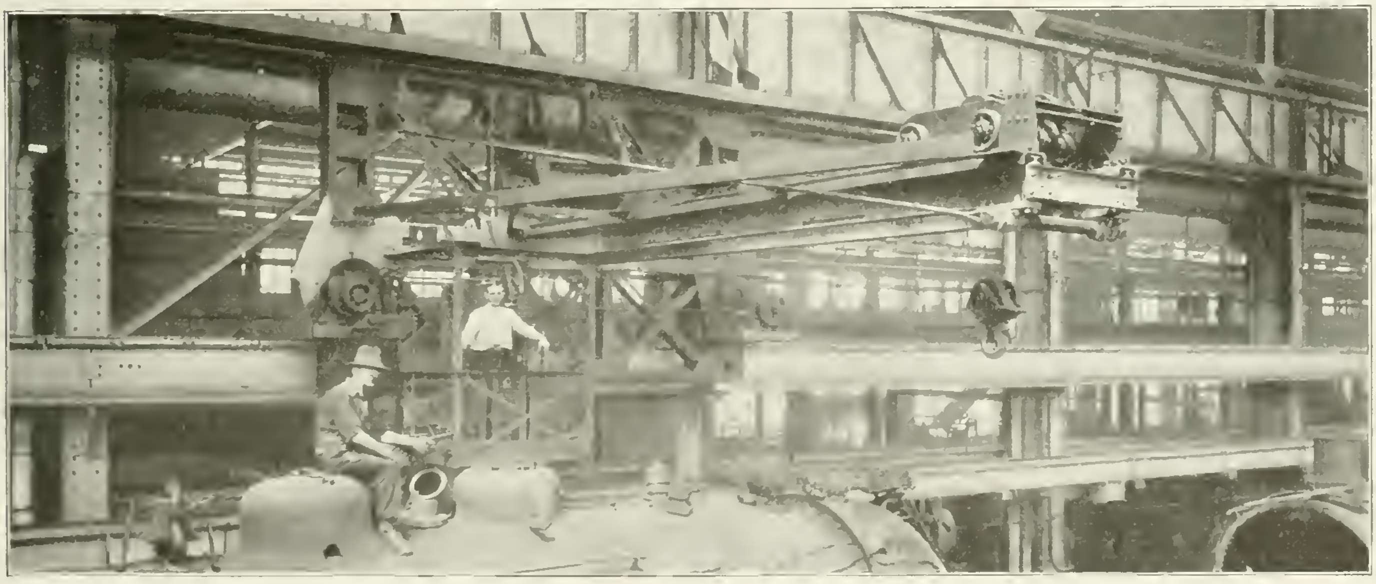
The shaper has an effective stroke of 17 in. with a cross feed of the table of 24 in. The vertical table feed is 15 in. and the greatest distance of the table to the ram is 16 in. The feed of the tool is 7 in. and the diameter of the head 8 in. The number of strokes per minute may be adjusted from 6 to 120.

TRAVELING WALL CRANE

The traveling wall type of crane has proved its value in the satisfactory solution of handling problems in many plants. Used as an auxiliary to the overhead cranes, it avoids delays and congestion and leaves the overhead cranes free for heavier loads and longer runs. The crane shown is designed and built by the Toledo Bridge & Crane Company, Toledo, Ohio. The four-motor type drive is used and arrangements can be made for either direct or alternating current motors. The crane is regularly furnished in capacities of three and five tons and for an effective reach up to 30 ft.

The back framing and the boom consist of rolled steel channels, beams, plates and angles, combined in a rigid structure. Truss rods or eye-bars give stability to the boom. Two motors connected in parallel and operated through one controller are provided for the longitudinal travel. The motor pinion engages directly into the driving gear which is pressed and keyed onto the double-flanged cast-steel truck wheel. The thrust wheels at the top and bottom are turned from solid cast steel blanks. A foot brake operated from the cage is provided to effectually control the longitudinal travel and to stop the crane without the necessity of reversing the motors. The brake is of the band type, the brake wheel being mounted directly on the armature shaft of one of the motors. The operator's cage, made of structural steel with a plank floor, is of sufficient size to contain all controllers, the switchboard and resistance, and still leave ample room for the operator. When desired the cage can be omitted, rope-operated controllers provided and all operations can then be accomplished from the floor. With the floor-operated type the foot brake is omitted and a solenoid brake provided, the latter being attached directly to one of the driving motors. A bumper bar and rail checks are provided at the end of the boom.

The hoisting mechanism consists of a one-piece cast frame on which is mounted the hoisting motor with its train of gears, the solenoid brake and hoisting drum. The gears are of cast steel. All pinions are of forged steel, machine cut and fully enclosed. The bearings are phosphor bronze, of the split shell type, the grey iron bearing caps being held in position with through bolts. The shafts are turned and ground to size from open hearth steel bars and shouldered to prevent excessive end play. Gears and pinions are keyed and pressed onto their shafts. The hoisting cable leads from the drum through one set of idler sheaves on the trolley, through the bottom block sheaves, then through the second set of sheaves on the trolley and is anchored at the end of the boom. The solenoid brake performs two functions. It serves to stop the motor, thus providing for rapid reversal, and it also acts as a holding brake when the load is brought to rest through the dynamic braking control. The brake wheel is mounted directly on the extended armature shaft, and is accurately machined and balanced. The brake is automatic in operation, and is so arranged and connected that should the supply of current fail or the controller be brought to the neutral or off position, the brake at once becomes operative, prevents the load from falling or slipping and is released only by the application of power or by spread-



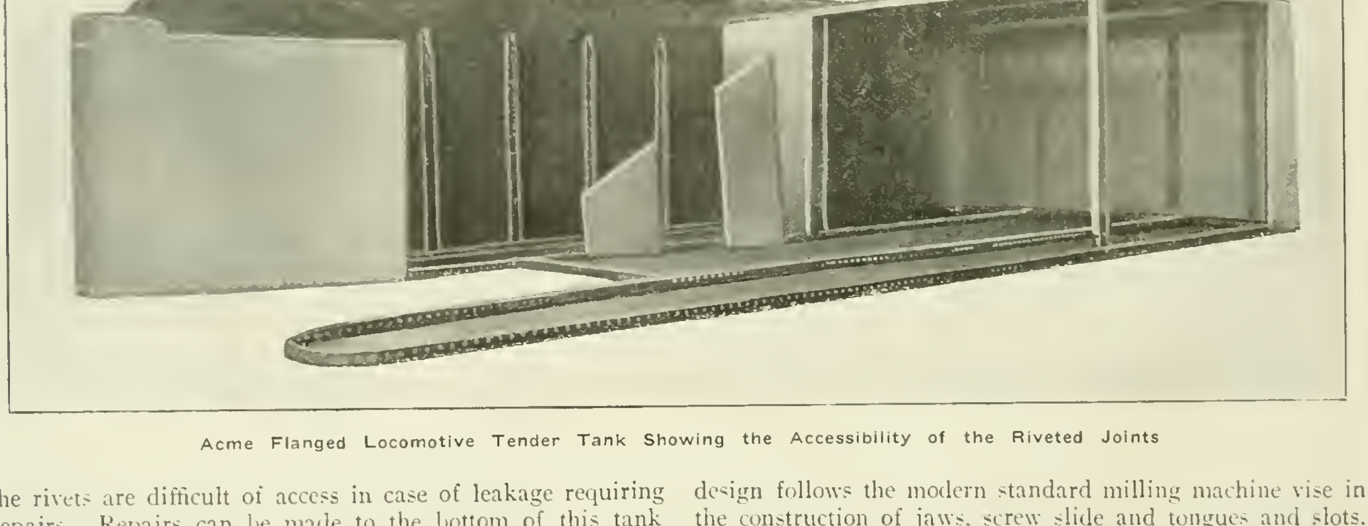
Traveling Wall Type Crane in a Longitudinal Shop

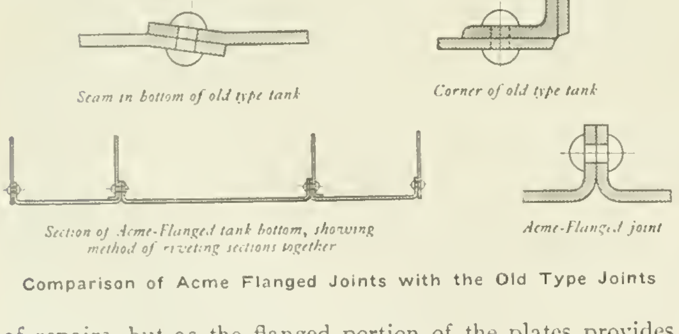
ing the brake arms against the tension of the springs. When alternating current motors are used the hoist motor is provided with a solenoid brake and the standard band type of mechanical brake is applied. This brake is of the screw friction type, automatic in operation, and the load can be lowered only by operating with power in the lowering direction.

THE ACME FLANGED LOCOMOTIVE TENDER TANK

A locomotive tender tank formed of flanged steel plates is being placed in service on a number of large railroads by the Locomotive Tank Company, New York.

The special feature of this tender tank, which is known as the Acme flanged tank, is the flanging of the edges of the plates inwardly and riveting them together inside of the water space instead of on the under side of the tank, where the rivets are difficult of access in case of leakage requiring repairs. Repairs can be made to the bottom of this tank without raising it from the frame, as all of the riveting is done on the inside. This feature not only reduces the cost of repairs, but as the flanged portion of the plates provides a means of riveting them together, a great number of the angle irons and rivets required in the older types of tender tanks are eliminated.


Acme Flanged Locomotive Tender Tank Showing the Accessibility of the Riveted Joints



Comparison of Acme Flanged Joints with the Old Type Joints

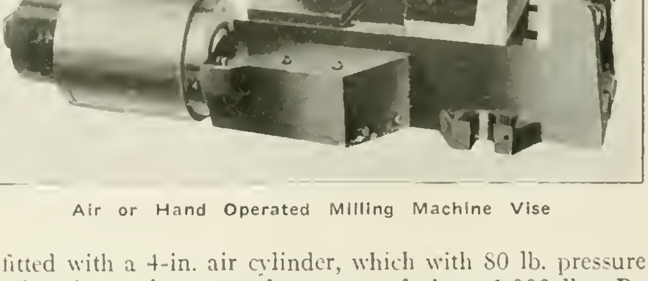
Other advantages of this type of construction are that no rivets or holes pass through the top or bottom of the plates and the bottom of the tank sets firmly and smoothly on the tender floor, thus evenly distributing the strains. The absence of angle and T-irons and sharp corners in the interior of the tank also prolongs the life of the bottom. The center section or pan is directly under the water intake and tends to retain in it such pieces of coal, cinders and sediment as might pass through the screen and if carried on with the water would interfere with the operation of the injectors.

It is stated that the tests to which this tender tank has been subjected and the record of costs for material and manufacture indicate that it will prove to be a very economical method of locomotive tender construction.

PNEUMATIC MILLING MACHINE VISE

A milling machine vise, so designed that it can be operated by air or used as an ordinary hand-operated vise, has been placed on the market recently by the American Pneumatic Chuck Company, Chicago. This vise is made so that it may be placed either crosswise or lengthwise on the table of the machine. No part extends above the jaws which hold the work, so the cutters can pass over the entire vise. The design follows the modern standard milling machine vise in the construction of jaws, screw slide and tongues and slots. The body is made of a steel casting and the entire construction is substantial and rigid. The adjusting screw slide is built into the body of the vise, becoming practically a part of it. It is claimed that this vise is economical in the use of air due to the fact that after the piece of work has been gripped by the jaws, the air supply may be shut off entirely without the jaws loosening up.

The power required to hold a piece of work in any vise is greater than usually realized, and this milling machine vise is fitted with a 4-in. air cylinder, which with 80 lb. pressure on the piston gives a total pressure of about 1,000 lb. By means of a toggle joint arrangement on which patents are pending, this initial pressure is increased by more than 30 to 1, which, making allowances for friction, etc., gives a final gripping power at the extreme point of movement of the


Air or Hand Operated Milling Machine Vise

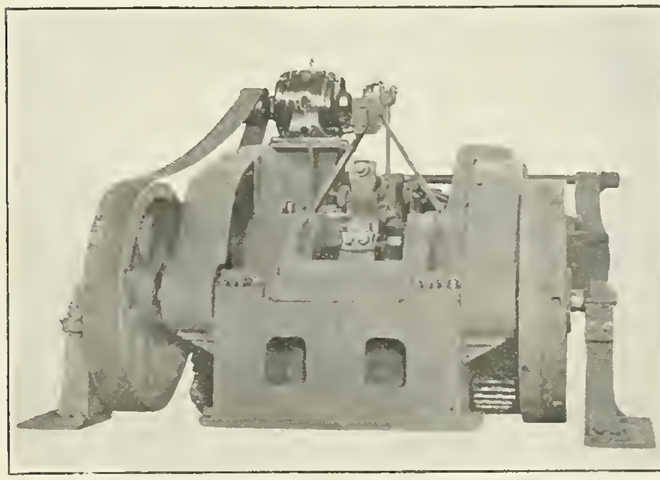
piston of about 25,000 lb. pressure on the work. While the vise is capable of exerting this heavy pressure, it is claimed that the jaws can be adjusted so that the most delicate work can be held without crushing it. The double acting air cylinder opens and closes the jaws practically instantaneously, but they can be so regulated as to travel slowly towards the work. The air valve is mounted directly on the cylinder and requires only one hose connection.

HEAVY UPSETTING FORGING MACHINE

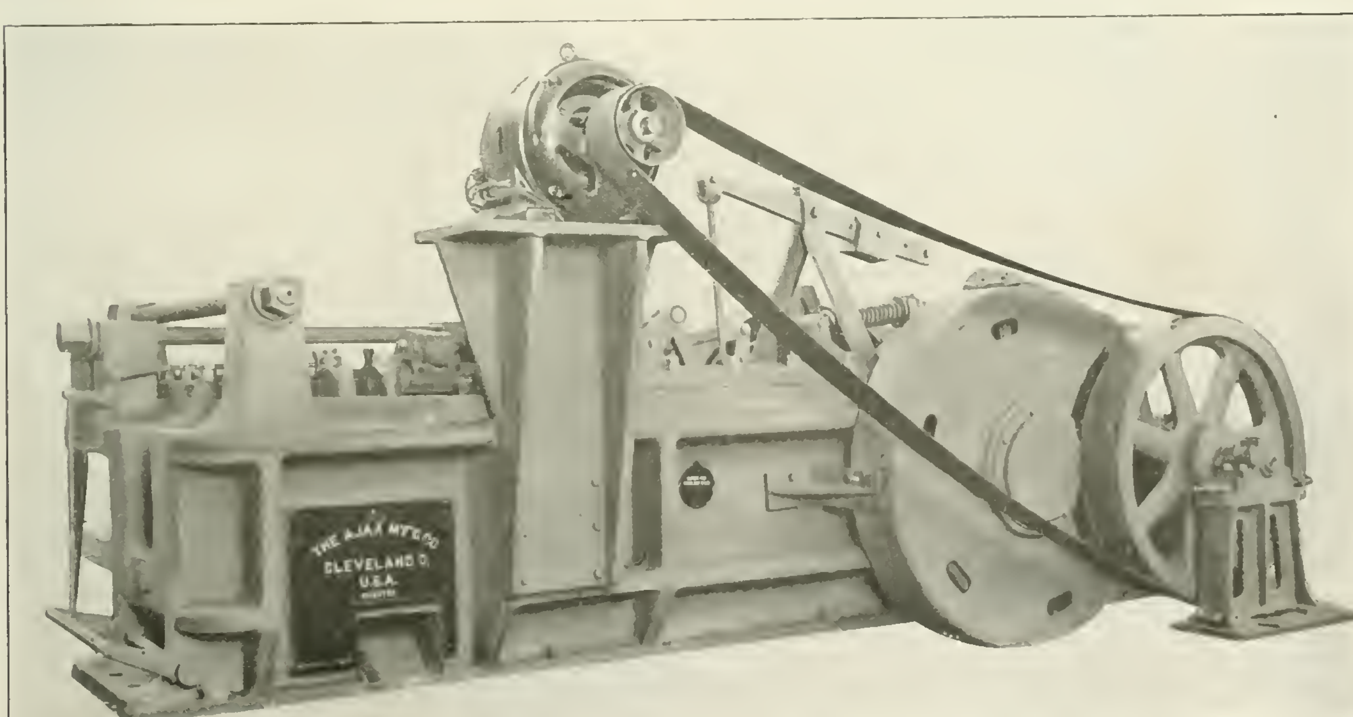
The steady increase in the use of alloy and high carbon steels in forging has created a demand for heavy forging machines to stand up under the increased strain of working these materials. Accurate, economical, high production is also desirable and the upsetting forging machine illustrated has been designed by the Ajax Manufacturing Company, Cleveland, Ohio, to include all of the above qualities. The machine weighs 12,000 lb., which is about 40 per cent heavier than the old 4-in. model. The steel bed is reinforced with tie rods. The crank shaft bearings in the continuous housing of the bed are of the sleeve type, phosphor bronze bushed, and the steel gears and pinions are especially treated with teeth cut from solid blanks. The positive die grip is protected by a breaker bolt in the safety knuckle, the latter being operated by a patented lock device which stops the dies in the wide open position and stops the header slide at the back of its stroke.

The capacity of the new forging machine has been demonstrated in tests recently conducted at the Cleveland plant. It is stated that a 4-in. machine, in a single blow, forged a disk 9½ in. in diameter and 1¼ in. thick on the end of a 3½-in. bar of steel of .60 carbon content at a cherry red heat. In doing this eight inches of stock were gathered and flattened out without stalling the machine.

The slides are considerably increased in length and operate on overhung bronze faced bearings, thus preventing undue wear by the accumulation of scale and dirt on the sliding surfaces. Arrangement is made for ample lubrication. The header slide carries a triple-high tool holder, so constructed as to permit its adjustment to any desired location of the grooves in the gripping dies. The die slide carries the moving die in a box shaped recess which gives substantial support against the backing plate during the heading operation. Local wear in the backing plate and the resulting tendency of the die slide to rock is thus eliminated. In order to transmit the power necessary for the making of large forgings, a twin gear drive from the pinion shaft to the crank shaft is employed on all machines of the larger sizes. This gives equal torque to both ends of the crank pin, greatly decreasing the strain in this part. In addition, the crankshafts have been nearly doubled in weight.



Rear View, Showing Twin Gear Drive

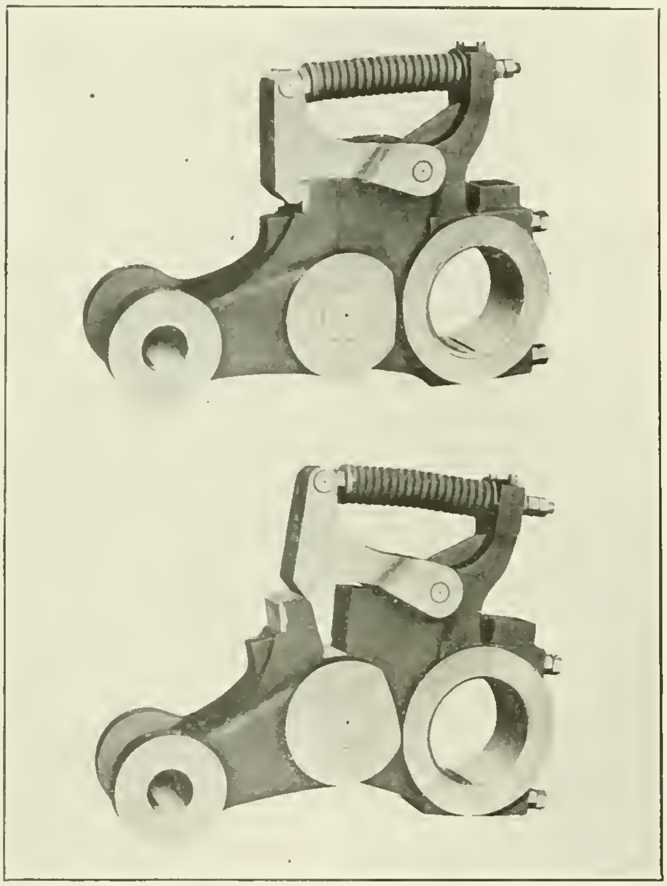


New Model Forging Machine Designed for High Production

The self-adjusting safety pitman, the construction of which is shown in the photograph, is a new feature. The middle center is slightly raised above the line of the other two so that a pressure on the ends results in a buckling tendency. This buckling is resisted up to a predetermined pressure by the latch held in place by the heavy coil spring. When the limiting pressure is reached the latch jumps up, giving complete relief without the building up of additional pressure. On the return stroke the pitman straightens out, the

latch drops into place and the machine is ready to go on with its work with no delay. By tightening or loosening the spring a nicety of adjustment can be obtained which permits the working of the machine to its full capacity with assurance that the limit of its strength will not be exceeded. Machines equipped with this type of pitman have been in operation continuously for the past three years and have been giving a satisfactory performance under the most severe service tests.

In order to increase the capacity of the machine to correspond to its increased power and strength, the stock gather, die opening and die height have been greatly increased. The production of larger forgings in fewer operations is thus made possible and the additional space for the placing of more grooves in a single face of the die reduces the number of die changes necesssary. The machine is made in 4-in. and 5-in sizes.

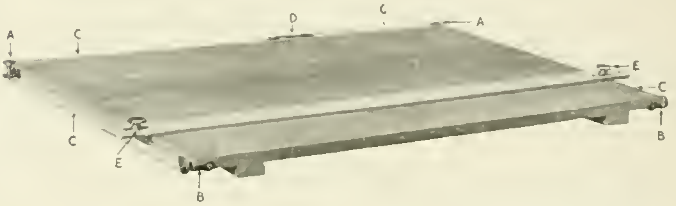


Safety Pitman in Operating Position and Sprung by Excessive Pressure

PARALLEL RULER ATTACHMENT

Several advantages result from the use of a parallel ruler attachment with a drawing board, one of the most important being the saving in time previously spent by the draftsman in watching the head of his T-square. The attachment shown herewith is more accurate than the average T-square and in addition can be adjusted at any required angle across the drawing board by means of the thumb nuts on the binding post.

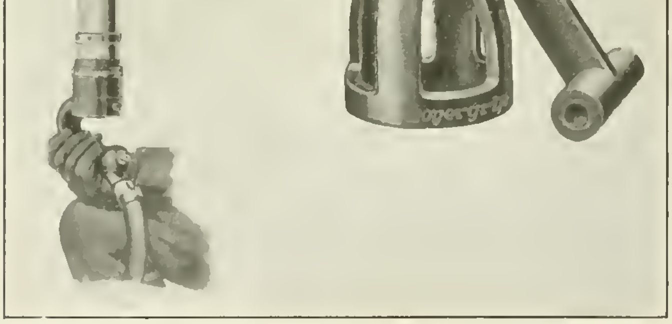
This parallel ruler has been placed on the market by the Economy Drawing Table Company, Adrian, Mich. It consists of a set of two double pulleys *A* attached to the back corners of the drawing board, and two single pulleys *B*, attached to the front corners. A steel piano wire *C* is placed around these pulleys, making a double lap along each end and back of the board. By crossing the wire at the back the upper laps at both ends must move forward and back simultaneously. The ends of the wire are joined together at the back by a steel spring *D*. Both ends of the straight edge are attached to the upper wire at the ends of the board by binding posts *E*, thus making it possible to move one end of the straight edge without moving the other a corresponding amount in the same direction. All pulleys, brackets and binding posts are made of brass accurately machined, polished and lacquered The attachment is accurate, as both ends of the straight edge are attached to the same wire and can be moved back and forward only simultaneously. The straight edge can be lifted clear of the board for changing drawings without loosening any thumb nuts, and can be set at any angle across the board by thumb nuts on the binding posts. The entire arrangement is simple, durable and easily applied.



Economy Parallel Ruler Attachment Applied to Drawing Board

BOYERGRIP FOR PNEUMATIC HAMMERS

The Boyergrip is a device recently brought out by the Chicago Pneumatic Tool Company, Chicago, which combines a convenient hammer grip with an absolutely safe set retainer. As shown in the illustration, it fits over the end of the riveting hammer and enables the operator to secure a firm grip without grasping the heated cylinder. This arrangement makes the operation of the hammer more convenient and allows the workman to drive hot rivets without danger of burning his hands. The device also provides an unobstructed view of the work from all angles. The Boyergrip is made of steel and is practically indestructible. A modified form of this device, which is well adapted for use on chipping and calking tools has also been placed on the market.



Combined Hammer Grip and Set Retainer

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

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WE GUARANTEE, that of this issue 12,000 copies were printed; that of these 12,000 copies, 10,803 were mailed to regular paid subscribers; 20 were provided for counter and news company sales; 219 were mailed to advertisers; 33 were mailed to employees and correspondents, and 925 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 24,200, an average of 12,100 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

In an effort to encourage more skilled workmanship the Canadian Pacific inaugurated a competition among apprentices at the Angus shops, and the five winning pupils were recently presented with prizes of books by James D. Muir, assistant works manager, at a gathering presided over by C. Kyle, supervisor of apprentices. There were present about 423 apprentices and Mr. Muir pointed out to them that it was only by diligent work that advancement to a marked degree was attained, and that full interest in their tasks was a necessity. Others who spoke were J. R. Ayers, general master painter; E. T. Spidy, production engineer; John Kennedy, piece work supervisor; Charles Bulley, class instructor of the apprentices, and J. W. Wood, shop instructor.

The rumor reported in the January issue that the Ministry of China has engaged four foreign experts to assist in the standardization of rolling stock is now abundantly confirmed by the arrival of these gentlemen in Peking. One is Frank H. Clark, formerly superintendent of motive power of the Baltimore & Ohio. The others are T. R. Johnson, formerly commissioner of railways, New South Wales, and latterly engaged in consulting work in London; M. Taton, personal representative of M. Painlevé, formerly Minister of War, France, who was engaged by the Ministry, but is unable to come at present, due to political conditions in France, and Dr. Hirai, the present Japanese Adviser to the Ministry. In addition to the standardization of rolling stock, this group will attempt to standardize signal practice, bridge dimensions and other maintenance practice.

In an article on the transport and coal question in the Börsen Courier, quoted in the Railway Gazette (London) a leading German manufacturer of locomotives says: "It might appear that the German locomotive industry is specially interested in receiving orders from the State Administration. The opposite is really the case. In the large locomotive works in Germany new locomotives are being built, mainly out of pre-war material, and production in the workshops has increased that it may be said to have reached the peace-time standard. The Hanoverian Maschinfabrik, for instance, is at the present time building some 32 new locomotives monthly, with the employment of 5,000 permanent workers. Having regard to the present economic situation in Germany, the only strange fact about this is that these locomotives are all sold to foreign countries. The prices which foreign countries are offering for German locomotives are such as to enable the manufacturers to provide themselves with all kinds of material, not only machinery, oil, etc., but also coal either from Germany or abroad."

The Brotherhood of Maintenance of Way Employees and Railway Shop Laborers has bought four clothing factories, and promises to reduce prices from 25 to 60 per cent. The factories include knitting and underwear companies at Ypsilanti, Mich., a glove factory at Williamston, Mich., and a tubing factory, making tubes used in gloves, in Watertown, N. Y. Unverified reports of such action have been in circulation since the authorization of such a campaign at the national convention of the brotherhood in Detroit, Mich., in September, 1919. The present report has been confirmed by officers of the brotherhood, who announce that the purchases thus far consummated represent an initial investment of approximately $1,000,000 and are "but the first steps" in a campaign to reduce the cost of living for members of the brotherhood. It is proposed to sell to the members of all railway brotherhoods.

North British Railway Changes

W. P. Reid, locomotive superintendent of the North British Railway, retired from active service at the end of December. Mr. Reid started his railway career in 1876 under the direction of Dugald Drummond, then locomotive superintendent of the North British railway, at the Cowlairs works. In 1883 he was placed in charge of the locomotive depot at Balloch, in 1889 he was removed to Dumfermline, in 1891 to Dundee, and in 1900 to St. Margaret's depot, Edinburgh, which is the second largest locomotive depot on the North British railway system. It was in 1904 that he was made locomotive superintendent of the North British railway.

Owing to the retirement of W. P. Reid, the position of locomotive superintendent will be divided, and Walter Chalmers, the present chief draftsman at the Cowlairs works, Glasgow, will become chief mechanical engineer with charge of all workshops and dock machinery, while the position of locomotive running superintendent will be taken by John P.

Grassick, at present district locomotive superintendent at the Eastfield depot. The headquarters will be at Cowlairs, Glasgow.

Mexico to Spend $2,000,000 for Equipment

An appropriation of 4,000,000 pesos, equivalent to $2,000,000, has just been authorized by the Mexican government for the purchase of rolling stock for the National Railways of Mexico. Most of the new equipment will be second-hand and will be purchased in the United States. There is at present such a shortage of cars and engines upon the different divisions of the National Railways that it is impossible to move but a small percentage of the traffic that is offered. Thousands of box cars have been wrecked by bandits and revolutionists during the last several years. The shops of the railroad at Saltillo, Aguas Calientes and other points are doing considerable work in the matter of reconstructing damaged cars and engines, but the number which is being turned out is far from sufficient to meet the demands of traffic. Thousands of new railroad crossties are needed to repair the rundown condition of the system. Large orders for materials have been placed in the United States and some shipments of crossties have been received. In the more isolated parts of the country where timber is scarce the sidetracks have been torn up by poverty-stricken natives and the crossties used for fuel.

Standard Cars and Locomotives

Up to January 20, 92,412 of the 100,000 standard freight cars ordered by the Railroad Administration in 1918 had been delivered, leaving 7,588 to be completed. Of the total, 12,680 were built in 1918 and 77,423 in 1919. All of the standard locomotives will have been delivered by the end of January, but 11 Mikados of a special order placed for the Central Railroad of New Jersey are scheduled to be delivered in March.

Most of the locomotives which the Railroad Administration has been using during the period of federal control on roads other than those of their owners have now been "unscrambled" by being returned to their owners. According to a recent report there were still 515 locomotives off their own lines, of which 95 were in the Allegheny region, 66 in the Central Western region, 135 in the Eastern region, 49 in the North Western region, 15 in the Pocahontas region, 104 in the Southern region and 51 in the Southwestern region, but 236 included those whose location off line is a system affair over which the Railroad Administration need not concern itself. The location of 155 was required by public necessity and apparently they will still be so required to be off line on March 1. The location of 95 off line was at that time required by public necessity but there was some prospect of relocating it before March 1 either through termination of the necessity, by a rearrangement of equipment, or by repair of unserviceable equipment in shop. Only 29 locomotives were classified as being off the line for reasons not required by public necessity.

MEETINGS AND CONVENTIONS

Air Brake Association.—The twenty-seventh annual convention of the Air Brake Association will be held at the Hotel Sherman, Chicago, from May 4 to 7, inclusive. The Air Brake Appliance Association will have charge of the exhibits.

Material Handling Machinery Manufacturers' Association.—The convention of this association which was to be held at the Waldorf-Astoria Hotel, New York, on January 29 and 30, has been postponed, and will be held on February 26 and 27. Manufacturers from any part of the United States will be welcome, and especially makers of overhead cranes, hoists, conveyors, trucks, tractors and trailers. Reservations for the luncheon may be procured from Z. W. Carter, secretary, 35 West 39th street, New York.

American Foundrymen's Association.—The board of directors of the American Foundrymen's Association, at its annual meeting held in Cleveland on January 13, voted unanimously in favor of holding the 1920 convention and exhibit of the association in Columbus, Ohio, during the week of October 4. The exhibition buildings on the Ohio State Exposition Grounds will be used for the exhibits. In addition, adjoining buildings provide lecture halls and meeting rooms, making it possible to hold all the activities of the association in one place.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 163 Broadway, New York City. Convention May 4-7, Hotel Sherman, Chicago.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—Arthur G. Henry, Illinois Tool Works, Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Laylor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—H. J. Smith, D. L. & W., Scranton, Pa.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Feb. 10, 1920	The Manufacture of Tool Steel, illustrated with moving pictures	F. B. Lounsberry	W. A. Booth	131 Charron St., Montreal, Que.
Central				H. D. Vought	95 Liberty St., New York.
Cincinnati				H. Boutet	101 Carew Building, Cincinnati, O.
New England	Feb. 10, 1920	Handling of Purchases and Supplies	E. J. Roth	W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Feb. 20, 1920	What the Railroads Must Do to Make Good After March 1	J. H. Hustis and L. F. Loree	H. D. Vought	95 Liberty St., New York.
Pittsburgh	Feb. 27, 1920			J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Feb. 13, 1920			B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Feb. 16, 1920	National Agreement	Frank McManamy	J. M. Byrne	916 West 78th St., Chicago.

PERSONAL MENTION

GENERAL

B. C. King has been appointed assistant general boiler inspector on the Northern Pacific, with headquarters at St. Paul, Minn.

B. C. Nicholson, general foreman of the Denison locomotive shops of the Missouri, Kansas & Texas, has been appointed mechanical efficiency inspector, with headquarters at Parsons, Kansas.

F. K. Tutt, acting general master mechanic of the Missouri Pacific with headquarters at St. Louis, Mo., has been appointed mechanical superintendent of the Missouri, Kansas & Texas.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. A. Bisset, general foreman of shops of the Atlantic Coast Line at Sanford, Fla., has been appointed master mechanic at Waycross, Ga., succeeding J. E. Brogden.

C. A. Conner has been appointed traveling engineer and trainmaster of the Green River division of the Denver & Rio Grande, with office at Helper, Utah, succeeding C. H. Wilcken, who has resigned.

F. A. O'Neill has been appointed road foreman of engines of the Erie, with headquarters at Cleveland, Ohio, succeeding J. E. Bleutge, resigned to accept a position as traveling engineer with the American Expeditionary Forces.

A. B. Shanks, general foreman of the Missouri, Kansas & Texas of Texas at Smithville, Texas, has been appointed master mechanic with the same headquarters, with jurisdiction over the points south of Waco, Texas.

SHOP AN ENGINEHOUSE

J. E. Brogden, master mechanic of the Atlantic Coast Line at Waycross, Ga., has been appointed superintendent of shops at Waycross, succeeding D. M. Pearsall, whose appointment as superintendent of motive power has already been noted in these columns.

J. E. Burke has been appointed roundhouse foreman of the Kansas City Southern at Pittsburg, Kans. He was formerly roundhouse foreman of the Chicago & Alton at Bloomington, Ill., resigning from that position in March, 1919.

W. J. Skelton, roundhouse foreman of the Missouri, Kansas & Texas at Denison, Texas, has been appointed general foreman there, succeeding B. C. Nicholson.

OBITUARY

William T. Gorrell, formerly master car builder of the Philadelphia & Reading at Reading, Pa., died December 13, 1919, at his home in Reading. Mr. Gorrell was born near Aberdeen, Md., on January 23, 1844. He was taught cabinet making by his father and then entered railroad work as a car builder in 1869 on the Central Ohio at Bellair, Ohio, later working at his trade on the Cleveland & Pittsburgh at Wellsville, Ohio, and the Pittsburgh, Cincinnati, Chicago & St. Louis at Dennison, Ohio. On April 15, 1873, he began work with the Philadelphia & Reading at the Reading car shop and was successively foreman of the passenger car department, general foreman and assistant master car builder, and on March 1, 1897, was appointed master car builder, which position he held until he was retired and pensioned when he reached the age of 70, on February 1, 1914.

SUPPLY TRADE NOTES

The Streator Car Company, Streator, Ill., is building a new plant at Kankakee, Ill., which will be devoted to the building of steel cars.

The Railway Motor Car Company, Hammond, Ind., contemplates the erection of a power plant and machine shop at its plant to cost approximately $200,000.

Arthur Haller, of the New York office of the American Locomotive Company, has been promoted into the company's sales department, with headquarters at Chicago.

The Union Tank Car Company announces that it has acquired 120 acres of land in Lima, Ohio, with the intention of erecting car shops in the future on the site.

Willis E. Martin, treasurer of the H. K. Porter Company, Pittsburgh, Pa., died on January 12, after a prolonged illness. Mr. Martin had been connected with this company for 44 years.

H. P. Wingert has resigned his position as general purchasing agent of the American Brake Shoe & Foundry Company to become the president of the American Commodities Company with offices at 30 Church street, New York. This company is engaged in the handling of fuel and foundry supplies and railway materials. Mr. Wingert is well known in railway circles. Beginning his business life as a messenger boy, he became a telegraph operator and later held positions of responsibility with the Pennsylvania Railroad, the New York Central and the Central Railroad of New Jersey. He resigned as assistant to the purchasing agent of the Central Railroad of New Jersey to become purchasing agent of the American Brake Shoe & Foundry Company at the time of its organization.

H. P. Wingert

The Air Brake Safety Appliance Company has been incorporated at Indianapolis, Ind., with a capital of $10,000 for the manufacture of a safety device to be used in connection with air brakes.

A. H. Hawkinson, assistant manager of the Garratt-Callahan Company, has been appointed sales manager with jurisdiction over the railroad and industrial departments, succeeding E. V. Sackett.

C. M Rogers has resigned as supervisor of stationary plants on the Chicago, Rock Island & Pacific, with office at Chicago, to become manager of service of the Locomotive Fire Box Company, Chicago, with headquarters at 630 Marquette building.

C. C. Humberstone has been appointed Chicago sales manager of the Anchor Packing Company, Philadelphia, Pa., under the jurisdiction of J. T. Landreth, western sales manager, with headquarters at Chicago. Mr. Humberstone was formerly with the engineering department of the Pennsylvania.

The Duff Jack Sales Company, Ltd., located at 245 Oxford street, London, England, has been formed to represent the Duff Manufacturing Company of Pittsburgh in the British Isles, and has been given the exclusive agency in this territory for Duff and Barrett jacks.

The Chicago Flexible Shaft Company, Chicago, has opened a New York office at 350 Broadway, for the distribution and sale of furnaces, forges and heat treating equipment. The office will be in charge of J. W. Lazear, formerly with the Brown Instrument Company, Chicago.

I. F. Baker, of the Westinghouse Electric International Company, who has been located in the New York office of that company for the past two years, is now on his way to Tokio, Japan, where he will act as a special representative of the Westinghouse International Company.

A. S. Winter has resigned as advertising manager of the William Powell Company, Cincinnati, Ohio, to become connected with the sales force of the Fairbanks Company, New York, and will represent this company in Southern Ohio territory. Mr. Winter will have his headquarters at the Pittsburgh office of the company.

A. R. Horn, who served for over ten years as inspector of devices of the Q & C Company, New York, in connection with its Chicago office, died at Minneapolis, Minn., on December 28, 1919, at the age of 70. Before his connection with the Q & C Company Mr. Horn was division superintendent of the Wisconsin Central Railroad.

Evarts S. Barnum of the G. M. Basford Company, New York, died at his home in Ridgewood, N. J., on February 3, of pneumonia, after an illness of eight days. Mr. Barnum was born in Louisville, Ky., in 1883 and received his education at Purdue University, from which he graduated in 1906. His entire business life was connected with railroad work. Immediately upon his graduation from the University, he entered the service of the Pennsylvania Lines West as apprentice and worked successively as apprentice, machinist, foreman, general foreman, roundhouse foreman and motive power inspector. Leaving the railroad in 1917 he joined the editorial staff of the Simmons-Boardman Publishing Company as an associate editor of the Railway Age and the *Railway Mechanical Engineer* and later became associated with the G. M. Basford Company and was in charge of the copy department of that company.

E. S. Barnum

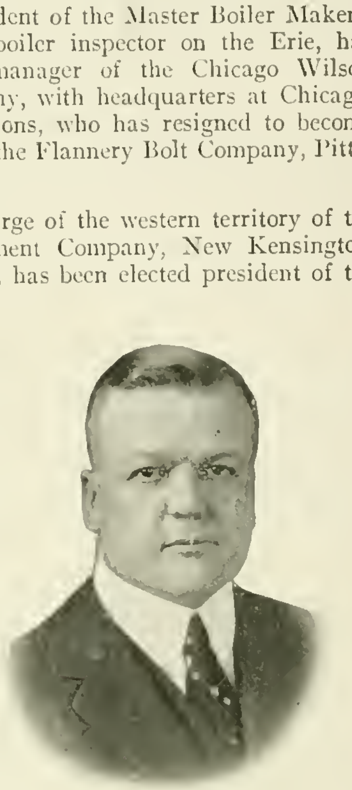
The Wm. Graver Tank Works, Chicago, announces that it has changed its name to the Graver Corporation. There is no change in the management, ownership or directorate.

C. H. Beck, special representative of the Safety Car Devices Company at Pittsburgh, Pa., succeeds C. R. Ellicott as assistant eastern manager at New York.

Errett V. Sackett, who has been manager of the railroad department of the Garratt-Callahan Company for the past five years, has resigned to accept a position as assistant to the president of the Seller Distributing Company, Detroit, Mich., taking charge of sales. This company is the foreign distributer for a large number of American companies. Mr. Sackett left for Europe early in January to study conditions in England and the Continent, to return about May 1.

C. P. Patrick, vice-president of the Master Boiler Makers' Association, and general boiler inspector on the Erie, has been appointed general manager of the Chicago Wilson Welding & Repair Company, with headquarters at Chicago, succeeding E. S. Fitzsimmons, who has resigned to become assistant sales manager of the Flannery Bolt Company, Pittsburgh, Pa.

Arthur A. Frank, in charge of the western territory of the Standard Railway Equipment Company, New Kensington, Pa., with office at Chicago, has been elected president of the company. Mr. Frank was born at St. Louis, Mo. For a number of years he was connected with the transportation and mechanical departments of the Missouri Pacific. In 1911 he entered the supply trade field as secretary to the president of the T. H. Murphy Company, New Kensington, Pa., and later was promoted to the position of factory manager. In 1914 he was appointed sales agent of the Standard Railway Equipment Company in charge of the southwestern territory, with office in St. Louis, Mo. In July, 1918, he was transferred to Chicago, in charge of the entire western territory, which position he retained until his recent election as president. In addition to the presidency of the Standard Railway Equipment Company he will retain his office as vice-president of the Pressed Steel Manufacturing Company, the Imperial Appliance Company and the Union Metal Products Company.



A. A. Frank

The Cleveland office of B. M. Jones & Co., Inc., New York, selling agents for Mushet steels and Taylor iron, has been moved from 824 Engineers building to 115 St. Clair avenue, N. W., where the office and warehouse have been combined. Walter E. Sargent, formerly of Detroit, Mich., is now connected with the New York sales office of the company at 192 Chambers street.

The Locomotive Export Association of New York City has filed papers with the Federal Trade Commission in accordance with the provisions of the Webb-Pomerene Act setting forth the details regarding its organization to export locomotives and parts thereof. The stockholders include the Baldwin Locomotive Works, the American Locomotive Company and the Montreal Locomotive Works.

The Vanadium Corporation of America, 120 Broadway, New York, has bought all of the properties, excepting cash, receivables and securities, of the Primos Chemical Company, the Primos Exploration Company, and the Primos Mining & Milling Company, producers of vanadium, molybdenum, tungsten and other steel alloys, and having valuable deposits of these elements in Colorado, and a large refining plant at Primos, near Philadelphia, Pa.

The Norton Company, Worcester, Mass., has under construction a new plant at Hamilton, Ont., for the complete manufacture of Norton wheels. The manager of the new plant is R. C. Douglas, formerly a representative of the com-

pany in upper New York state and Ontario. Mr. Douglas will be assisted in his work of organization by several foremen from the Worcester plant. It is expected that the Hamilton plant will be completed, ready for operation, by April or May.

Arthur E. Blackwood, manager of the New York office of the Sullivan Machinery Company, Chicago, has been promoted to vice-president in charge of finance and accounting, with headquarters at Chicago. Louis R. Chadwick, manager of the company's office at Spokane, Wash., has been transferred to the New York office, succeeding Mr. Blackwood. Robert T. Banks, sales engineer, with office at El Paso, Tex., has been promoted to manager of the Spokane office, succeeding Mr. Chadwick.

Joseph Robinson, the inventor of the Robinson connector and formerly president of the Robinson Connector Company, has again become associated with the company. This follows an absence from the company of two years during which time Mr. Robinson has had no managerial or mechanical association with it. In his new association he will act in an advisory capacity, working in co-operation with A. R. Whaley, vice-president of the company and formerly vice-president of the New York, New Haven & Hartford Railroad. Mr. Robinson was born in Dayton, Wash., on July 21, 1889. His family later went east to Illinois where, after leaving school at the age of 12, he worked on a farm until he was 14. He then went west again and worked in a blacksmith shop until the age of 18 when he opened an office at Salem, Ore., as a designer of special machinery. While doing this work his attention was drawn to the need of a better means of coupling hose on railway trains. He worked out the design of the Robinson connector for this purpose and after a study of the problem he came east with the device in 1909 and in 1910 organized the Robinson Connector Company of which he became president. For the next eight years he devoted his efforts to the development of the business represented by the company, until 1918, when he turned his interest over to other hands who, since that time, have been developing the device, Mr. Robinson retaining only the ownership of the patents, but no other connection than lessor with the company, until his return to it as noted above.


Jos. Robinson

The Conradson Machine Tool Company, Green Bay, Wis., has been incorporated recently with C. M. Conradson, at one time associated with the Gisholt Machine Company and later engaged in general consulting work in tool design, as president. The products of the new concern, consisting of milling machines, lathes, planers and radial drills will be marketed by Joseph T. Ryerson & Son. Work was begun on the Conradson plant in the spring of 1918 and was completed recently. Equipment is installed and production now under way.

The Kearney & Trecker Company, Milwaukee, Wis., announces that since February 1, 1920, the Cleveland, Ohio, office and warehouse of the company has been located at 738 Superior avenue, N. W., where larger quarters are occupied and where a line of Milwaukee milling machines, attachments and accessories will be carried. C. J. Sturgeon, formerly with the W. M. Pattison Supply Company, Cleveland, will be in charge of sales in the Ohio territory, succeeding C. C. Bauschke, who has resigned to engage in business on his own account.

The Westinghouse Air Brake Company, Pittsburgh, Pa., has created an export department to provide facilities adequate to handle the increasing export business and to develop its foreign trade to a greater extent than has been heretofore possible, with headquarters in the Westinghouse building, Pittsburgh, Pa. E. A. Craig, who has been appointed manager of the export department, has been associated with the Westinghouse Air Brake Company for 32 years. The new department will be represented in the New York office by W. G. Kaylor, and in South America by R. M. Oates.

Lester W. Collins has been appointed chief engineer of the Refrigerator Heater & Ventilator Car Company, with offices in the Merchants National Bank building, St. Paul, Minn. During the war emergency, Mr. Collins was connected with the United States Department of Agriculture as refrigeration technologist in charge of the development of a standard heater car for the protection of perishable lading in transit, for the refrigerator car committee appointed by the United States Railroad Administration. For seven years previous to his government service, he was an assistant to H. B. MacFarland, engineer of tests of the Santa Fe, and he was in charge of the special transcontinental tests made for the Santa Fe Refrigerator Despatch Company, on California fruits and vegetables handled in this company's equipment.

Kingman Brewster, until recently associated with the Greenfield Tap & Die Corporation, has been appointed president of the Millers Falls Company, Millers Falls, Mass. Born in Worthington, Mass., in 1882, Mr. Brewster was educated in the public schools of that town, Williston Seminary, Amherst College and Harvard Law School. He graduated from the latter in 1911 and in the same year was admitted to the bar in Oregon, practicing law there until 1914. He returned east to practice law in Massachusetts and in 1917 served as registrar and counsel of the Federal Land Bank of the First District; also counsel for the Besse System stores and other corporations. In 1918 Mr. Brewster became vice-president and general sales manager of the Greenfield Tap & Die Corporation. Mr. Brewster has recently been appointed to his new position as president of the Millers Falls Company.


Kingman Brewster

The Falls Hollow Staybolt Company, Cuyahoga Falls Ohio, announces the appointment of the following sales representatives: Charles Hubbard & Co., 81 Fulton street, New York; Warren Corning & Co., Transportation building, Chicago; Certes Supply Company, Frisco building, St. Louis, Mo.; Spalding & Small, 1010 Hurt building, Atlanta, Ga.; Read-Rittenhouse Company, 1234 Commercial Trust building, Philadelphia, Pa.; Berger-Carter Company, Tenth and Mississippi streets, San Francisco, Cal.; A. M. Castle & Co. of Washington, Seattle, Wash.; and Austin & Doten, 102 North street, Boston, Mass.

The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has announced the following promotions among its officers at East Pittsburgh: Alexander Taylor, for many years manager of works, has been made assistant to vice-president in general charge in all plants of production, stocks and stores. R. L. Wilson, general superintendent, has been promoted to works manager of the East Pittsburgh works. E. R. Norris has been appointed director of works equipment in charge of machinery, tools and methods in the various plants. Other appointments include: G. M. Eaton, chief mechanical engineer of the company; C. W. Johnson and H. W. Cope, assistant directors of engineering; C. H. Champlain and E. S. McClelland, assistant works managers; F. E. Wynne, manager of the railway equipment engineering department; and G. H. Garcelon, manager of the small motor engineering department.

A. N. Lucas, superintendent of the locomotive shop of the Chicago, Milwaukee & St. Paul, at Milwaukee, Wis., left the service of the railroad February 1 to become district manager of the Oxweld Railroad Service Company, with headquarters at Chicago. Mr. Lucas was educated in the public schools of Green Bay, Wis., and entered railway service at that point as a boilermaker apprentice. Late in 1881 he went to the Chicago & North Western shops at Escanaba, Mich. He remained there until January, 1883, and then returned to Green Bay, Wis., to enter the service of the Milwaukee Northern, now part of the Chicago, Milwaukee & St. Paul System. Here he was subsequently appointed boilermaker foreman. In January, 1901, he was transferred to Dubuque, Iowa, in charge of the boiler shop, remaining there until April, 1904, when he was transferred to the Milwaukee shops. Soon after this he was advanced to the position of general foreman of boiler work for the entire system. In May, 1917, he was promoted to the position of assistant superintendent motive power and a year later was placed in charge of the locomotive department of the Milwaukee shops as shop superintendent. Mr. Lucas is a past president of the Master Boilermakers' Association and is at the present time a member of the executive board of that organization.

A. N. Lucas

The Barco Manufacturing Company, Chicago, has increased its capital stock to $500,000 and contemplates building a new factory to accommodate the manufacture of several new devices which it expects to put on the market in the near future.

The Pollak Steel Company, Cincinnati, Ohio, manufacturers of railroad car axles, locomotive forgings and heavy forgings for marine and machine builders, with plants at Cincinnati and South Chicago, Ill., announces that it has recently added to its South Chicago plant a large extension for the manufacture of drop forgings for the automobile, tractor and agricultural implement trade and has added to its Cincinnati plant a large extension for the manufacture of automobile parts. The Pollak Steel Company has also just closed negotiations with the Interstate Iron & Steel Company, Chicago, for the purchase of its rolling mill property at Marion, Ohio. In addition to its manufacture of specialties, such as automobile parts and drop forgings, which cannot be measured on a tonnage basis, this now gives the Pollak company a capacity of both forged and rolled products of approximately 300,000 tons a year.

S. F. Bowser & Company, Inc., have extensive plans under consideration for expansion during the present year. The company plans the erection of a warehouse and office building at Dallas, Tex., and the organization of a subsidiary corporation to be known as S. F. Bowser & Company of Texas, for the sale of the Bowser products throughout that state and adjacent territory. E. P. Murray, formerly assistant general sales manager, with headquarters at Chicago, will assume the management of the new company at Dallas. During the war the company closed its branch offices at Denver, Colo., Memphis, Tenn., and St. Louis, Mo. These offices will be re-established, A. S. Bowser, assistant to the treasurer, with headquarters at Fort Wayne, Ind., having been appointed manager of the Denver office; B. L. Prince, who has been district manager of the Dallas office, has been transferred to the Memphis office, and Willard D. Smith, connected with the sales department, has been appointed manager of the St. Louis office. A new district office will be established at Detroit, Mich., and L. E. Porter, assistant district manager at Fort Wayne, Ind., has been appointed district manager of the new Detroit office.

National Steel Car Company Changes Hands

Robert J. Magor and associates have bought the plant and property, and taken over the assets and liabilities of the National Steel Car Company, of Hamilton, Canada, and will continue the business under the name of the National Steel Car Corporation. The plans of the new corporation are to substantially increase its freight car manufacturing facilities and also develop on a large scale the motor truck business, which in the old company was only carried on in a very small way.

R. J. Magor

Mr. Magor, who is president of the Magor Car Corporation, New York, engaged in the car building business, has been elected president also of the new corporation. He was born on July 6, 1882, at Montreal, Canada, was educated in high schools and also received private tuition. In November, 1905, he entered the car building business with the Canadian Car & Foundry Company and in June, 1910, left the service of that company to take over the management of the re-organized Magor Car Company plant at Passaic, N. J. Since Mr. Magor took over the management of this plant the production has been increased ten times, and extensions are now being made, to be completed in the early spring, that will double the present capacity of the plant. In 1912 Mr. Magor assisted in designing the plant of the National Steel Car Company, Hamilton, Canada, and two years later was elected to the board. In the early part of 1919 he was made consulting vice-president, and as the company sustained large losses on a French war contract it was necessary to reorganize it, additional capital being put in. This was done by submitting to the company a proposition of purchase, which was accepted, and on December 18, 1919, the purchase was completed and Mr. Magor elected president of the National Steel Car Corporation, Ltd.

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Lubrication of Cylinders

Among the defects which, like hot boxes, seem to recur at more or less regular intervals, one of the most troublesome is repeated failures of cylinder packing. When such an epidemic occurs the blame is usually placed on the material from which the rings are made, the lubricating oil, or the condition of the feedwater, but very often it is necessary to make some changes in the design of the locomotive before the trouble is overcome. It is generally admitted that more difficulty is experienced in lubricating the cylinders of superheated locomotives, yet the quality of the oil apparently is not as important as the method of operating the engine. By keeping air and front end gases out of the cylinders, oil with a low flash point can be used with good success. Vacuum relief valves have not met with favor on superheated locomotives and many roads consider even by-pass valves unnecessary.

The manner of application of the lubricant is a matter on which there is considerable difference of opinion. On some roads the oil is fed to the valves only; on other roads pipes are run to both the valves and the cylinders, while some lubricate the cylinders only. It is worthy of note that some remarkably good cylinder packing mileage records have been made on roads that have adopted the practice of lubricating only the cylinders. It is found that the exhaust steam carries enough oil to the valve cages to lubricate them properly and the small supply thus secured prevents heavy deposits of carbon around the rings. There is also a growing tendency to dispense with swabs on the piston rods. If the cylinder is properly lubricated the rod itself will carry enough oil to lubricate the rod packing. One road that had adopted cylinder lubrication without swabs averaged 65,000 miles per set of piston rod packing on superheated locomotives.

The higher cylinder temperatures obtaining with superheated steam have brought about marked changes in the design of piston packing rings. Wide rings have been found unsuited for this class of service and many roads have secured excellent service from rings having a width of 3/8 in. Gray iron does not possess sufficient strength for such narrow rings and special hard cast iron must be used. With the possibility of further increases in steam temperatures it may be necessary to make other modifications in the arrangement of the cylinders. The bronze faced piston offers another expedient for overcoming difficulties met in lubricating cylinders, but the fact that hard cast iron bull rings and cylinder bushings have been used successfully at extremely high temperatures indicates that it will hardly be necessary to have recourse to such construction.

The Possibilities of Electric Steel

The past decade has witnessed the substitution of steel castings for forgings in many locomotive and car parts. However, forgings are still used to a considerable extent for parts which are of such shape that they cannot readily be made on a forging machine or power hammer and could be made more cheaply if cast. While the field for ordinary steel castings has no doubt been practically exhausted, the possibility for wider application of electric steel castings in place of difficult forgings deserves thorough consideration. The casting of steel by the electric furnace process allows of more accurate control of the chemical composition and gives the product a higher tensile strength than can be secured by the open hearth process. While the cost is higher than that of ordinary steel castings, it would not be as great as the expense of making even a fairly simple forging.

By making some parts that are difficult to forge, such as safety chains for locomotives and cars, of electric steel, a marked saving should result and the strength might also be

considerably increased. For example, the specifications for electric cast steel chain specify an ultimate strength more than 40 per cent higher than for the corresponding size of welded iron or steel chain. Aside from the substitution of electric steel castings for forgings there should be a wide field for the use of this material in parts that are subject to failure. Often some cast parts of locomotives or cars do not possess sufficient strength and cannot readily be redesigned. The use of electric steel should overcome the difficulty, because it reduces the failures in sections that are difficult to cast and gives the parts both higher elastic limit and greater ultimate strength.

Helping the Valve Setter

Not infrequently a valve setter will connect up the motion work of a locomotive and roll the wheels, only to discover that the valve chamber bushings are a little too near together or perhaps too far apart. This necessitates removing the main valve to adjust or renew the bushings, resulting in a delay in turning the locomotive out of the shop which could have been avoided by careful inspection when the main valves were first removed. The distance from the link trunnion center to the steam edge of the back port of a locomotive with a Walschaert valve gear is very important; at least it should be the same on both sides, or the valve settter will be obliged to make corresponding alterations in the right and left valve stem lengths. If the check is made soon after removing the motion work from a locomotive there is ample time to make necessary alterations without delaying the valve setter later on. The article referred to on page 166 describes a gage for measuring this distance and also indicates a method of handling motion work and valve gear parts through the repair shop that has speeded up the work and made possible not only a greater output but a better operating valve gear.

Expressed in its simplest terms, the idea has been to get busy with the repair work just as soon as the locomotive was stripped, carefully checking all fundamental valve gear dimensions, making all valve gear parts correspond with the blue print, and getting those parts back to the erecting shop promptly. With this method locomotives are not delayed by mistakes found at the last minute. The valve gear parts, being all standard, go together quickly and easily. No extensive alterations are needed and the work of the valve setter is greatly facilitated.

Locomotive Frame Jaws

With the increased weight of locomotives it has been necessary to provide heavier driving boxes and much larger bearing surfaces between the driving box shoes and wedges and the frame jaws. It is not uncommon today to find frame jaws 6 or 6½ in. wide and 26 in. long. These jaws must be maintained both square and true. Every time the driving wheels revolve a pressure of 80,000 lb., or even more, is transmitted through the rods and wheels to the frame jaws. A variation of 1/64 in. is often sufficient to cause shoe breakage. Any one who has ever taken a file and attempted to straighten one of these large frame jaws will admit that it is both a long and tiresome job. The frames are composed of tough steel, which it is almost impossible to remove in any considerable amount with a file, and if the frame is worn out of true as much as 1/16 in., it is necessary to use a hammer and chisel to chip the bearing. This again is a time consuming operation.

It is absolutely essential that frame jaws should be maintained straight and it seems probable that a considerable saving could be effected by the use of a portable milling machine or grinder to do the work. Several successful portable machines of this type have been devised but have not been adopted to any considerable extent up to the present time. While the portable milling machines are reported to have given good satisfaction, it seems probable that the best results could be obtained by the use of a grinding machine. After a locomotive has been in service for eight or ten months without having its shoes and wedges renewed, a careful inspection of the frame jaws will usually show that they are worn slightly out of true and the bearing surface is hardened and glazed. In fact, the bearing surface of the frame jaw has the appearance of being almost casehardened. The hardened surface is very difficult to remove with a file and a milling cutter would have to take a cut sufficiently deep to get under it. This difficulty would be obviated by the use of a suitable grinding machine. Such machines have been developed and it is probable that they will be extensively used in the future.

College Men and Railroad Work

There has been much criticism of the shopmen's wage schedule, which was made effective by the Railroad Administration, because it does not provide for continuing special apprenticeship courses for college graduates in railroad shops. Some of the university authorities have even gone so far as to protest against this to the mechanical department of the Railroad Administration. One of our correspondents took up the cudgels in favor of the college man in a letter which was published in the *Railway Mechanical Engineer* of January, 1920, page 4.

Why should the college graduate be granted special favors? It is true that the railroads need him—and need him badly—but why discourage those who have not had this special training by practically serving notice on them that the college man, by being given special training, will be rushed into the more desirable official positions? On another page we publish data as to the number of apprentices in each craft on all of the roads under federal control. If the railroads will awaken to their full responsibility (and they have fallen far short of it) in the matter of recruiting and training their employees, the question of the college man in railroad service will automatically solve itself. Would it not be far better, for instance, to give those of the regular apprentices who show marked ability along certain lines an opportunity to take up a technical course or of adding to their technical knowledge beyond that which is taught in the ordinary apprentice courses on a road which has a modern up-to-date course of training? George M. Basford as far back as 1905 made the statement that "the special training of young men from without the ranks of the workers, for official positions, is fundamentally wrong, and furthermore it plays strongly into the hands of those who wish to see men levelled into classes and considered as on uniform levels as to the value of service." The railroads need technically trained men—lots of them—but why not go at the task of recruiting them in an intelligent, orderly and logical fashion?

Railroads will continue to take college men into their organizations from outside; but these men need not be given special privileges. Let them come into the organization on their ability and merits, and let them demonstrate their fitness for official positions in competition with others who may have less technical training. Do not further handicap the ambitious young man in the ranks, but rather get behind him and help him to overcome the handicap he already carries. Do not lose sight also of the fact that the successful executive must understand and appreciate the importance of the human factor; the man developed from inside the organization who has had to rub shoulders with the workmen in the formative period of his life may have advantages in understanding his

fellows, which if properly appreciated will give him a big advantage, if his technical training is continued, over the college man who comes into the organization for the first time after he has completed his technical training.

It may not be amiss in this connection to quote the following paragraph which is part of the conclusion of Mr. Basford's address to the 1905 convention of the Master Mechanics' Association: "For the men and officials of the future, technical education is required, but it must be obtained while the student otherwise prepares himself for his work. It must go hand in hand with his education in the service, and the education must be arranged especially to suit his needs. For the engineering education he must not be required to fit himself to existing schools. A new school must be developed specially for him. Instead of giving years to subjects which are merely good for mental training, he must give months to those which he will remember. Moreover, he must not separate himself from active work and responsibility for long periods in order to attend school."

Compulsory Metric Legislation

Elsewhere in this issue there is published a communication which calls attention to pending legislation making the use of the metric system compulsory. The author of the letter sums up the objections to the introduction of this system from the standpoint of the mechanical department and his arguments against its adoption should be carefully considered, as the issue is one which must be met squarely when the bill is introduced before Congress. Similar proposals for requiring the use of the metric system have been made before and have been rejected. Nevertheless, it is a mistake to assume that this measure will fail and that active opposition is not necessary. The present agitation for the metric system is due to the organized propaganda for the World Trade Club. It is sponsered by an individual who has made the metric system his hobby and has furnished large amounts of money to carry on the campaign, which has been so conducted as to make it appear that there is an overwhelming sentiment in this country for the adoption of the metric units. Unless industry in general makes known its opposition to the proposed legislation, there is danger that an active minority will be able to secure the enactment of legislation that will be burdensome and detrimental to the business of this country.

The metric system has had every opportunity to displace the present system in the United States. If its merits were as great as the advocates of this system claim, compulsory legislation should not be necessary to secure its adoption. Metric weights and measures have been used in France since 1793, and although penalties have been imposed for the use of the system formerly in vogue, the old units are in use even today in some of the French industries. The metric system has been legal in the United States for many years, but the advantages which it possesses have not proved sufficient to lead to the displacement of the English units. One prominent company which adopted the metric system when the business was founded abandoned it after 30 years. Other industries have had similar experiences, and at the present time the metric system is used in this country only in scientific work.

The metric system has been in use for a sufficient length of time to demonstrate whatever merits it possesses. The experience of other countries which have made the use of metric units compulsory proves that the old units never entirely disappear, but the metric units are added to those already existing, creating additional complication instead of the simplicity which is claimed for the system. Railroad men should realize the danger of compulsory metric legislation and should not allow laws which would affect them so directly to be passed without having their protest heard.

COMMUNICATIONS

I. A. OBSERVES ROUNDHOUSE OPERATION

Washington, D. C.

Dear Editor:

While Imperial Government are operate RR, I. C. C. detectors no longer can issue Form 5 invitation on hon. MM, so U.S.R.A. employ Jap detector as Shop detector. It our august duty to learn why former proud haughty RR and MM find impossible to keep running U.S.R.A. std. locomotive and car.

In pursuit of duty, Hon. Boss Detector send for me pos haste. I execute double quick to headquarters and learn Hon. Boss much exercised for Green River Jct.

RR building new roundhouse there, which are not perform right. Jap detector empowered to find what are wrong without delay.

Arrive Green River Jct. Find engines standing emitting steam to atmosphere, which are very cold and result in condensed steam return to earth like snow. Detect further find loco. house situate on bank of river which looks fine, but it are situate so close to bank, that outside wall turn table pit are in river. This account for phenomena observed when RH are approached. Juice have fail on motor, which make it nice to push 90-feet table by hand when river are on one side.

Roundhouse look out west, so when doors open let engine out, let wind in, which result in economy: as do without sweeper.

Find machines all motor push, which are good. However, main transmitter are blow out on occasion visit; no table, no machines, no pump, no water for boiler—whole damn works go to hell fast. But RR demand engines. RH foreman tells them, "engines here, he are impotent, come get 'em."

Detect no sand; reason it are froze. RR order when hot climate, get it when begin to be cold. No men to unload, stand, freeze tight, no sand. Picks, dynamite, sand stick by car like rock of gibralter. Build fire in car, thaw some, but only one sand-stove to dry sand. RH foreman, swear, say, "take sand to stick by job."

Report back Hon. Boss, Green River Jct. all right, if build right. Advise he send chief shop line-drawer to operate.

Ino Amsura.

EXHAUST NOZZLE AREAS

Chicago, Ill.

To the Editor:

In designing the essential features of a locomotive on the horsepower basis, the boiler pressure and the diameter of the cylinders can be inversely varied without affecting the result. To illustrate the point, the diagram herewith shows two locomotives having the same boiler, but by reason of using different pressures the cylinders have different diameters. The tractive effort, speed and power remain unaffected —the two machines are equal.

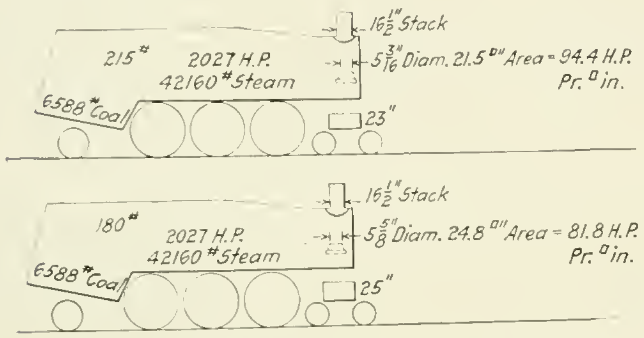
The amount of fuel burned and the water evaporated produce a constant volume of products for ejection through the stack, which of course remains unaltered, being designed on the basis of horsepower.

The function of the exhaust jet is to eject through this fixed size of stack a definite bulk and pressure of used material. A logical step is to make the exhaust nozzle size constant. In its course from the boiler to the nozzle tip the steam has been subject to equal losses from expansion, cool-

ing, etc. If it flows out at a constant pressure it performs a constant amount of work in clearing the smoke box, producing combustion. This would normally produce different back pressures in the cylinders, the higher in the smaller cylinder and a lower pressure as the diameter of the cylinder increases.

If now having laid down the prime idea, we admit that modifications should be, or would be introduced in practice, we still have little reason to believe that such a difference as exists under the present method (shown on the sketch—5 3/16 and 5⅝ in. diameter) would be required to accommodate them.

This is not a proposition to increase nozzle sizes. It would rather seem wise to accept the average of the present practice calculated on this new basis as the foundation.



The very considerable increase in size found practicable in tests not long since is consistent with this method. Just as reasonably would a reduction in size for other locomotives follow and benefit be expected. Averaging present practice would have:

61 hp. per square inch nozzle area for 1,200-hp. boiler.
69½ hp. per square inch nozzle area for 2,000-hp. boiler.
76½ hp. per square inch nozzle area for 2,800-hp. boiler.
79½ hp. per square inch nozzle area for 3,200-hp. boiler.

Thus a starting point could be established. So far as is known no practical systematic test of this plan has been made, but this idea is presented in the belief that it has legitimate interest for builders and users of locomotives.

S. C. Frank.

COMPULSORY METRIC LEGISLATION

San Francisco, Cal.

To the Editor:

Do the readers of your magazine fully realize the effort being made both in this country and in England to make the use of the metric system (the gram-meter-liter system) of weights and measures compulsory? A live, active organization is behind the movement, and so effectively has it worked that legislation is already pending both in our own National Congress and in the British Parliament which, if enacted into law, will not only make the decimal or metric system standard but will prohibit the use of our present system. From organized headquarters circulars are being sent out by the advocates of this legislation, urging the recipients of this literature to immediately write their Congressmen, the Bureau of Standards, Department of Commerce, President Wilson, Lloyd George and the British Parliament endorsing the proposed legislation, in order (so they claim) "that America and the English-speaking people in general may keep pace with the rest of the world" and our industrial development be no longer hindered by what they term "an antiquated jumble of weights and measures deliberately fastened upon us by Germany." So active have the champions of the metric system been that unless the opponents of the proposed change awaken to the seriousness of the situation there is great danger of this legislation being passed before those most vitally concerned really know what is going on.

It is not the purpose of this letter to discuss the merits of either system. We are willing to admit even that were we back to the days of creation or even to the beginning of our present industrial development we might favor the decimal system as being slightly superior to the system now in use. But the question of changing at this stage of the game to *any* system, no matter how superior it might be, is a very different proposition and involves such serious consequences that we believe it merits most careful consideration.

It is easy enough for a handful of college professors, or a World Trade Club with no financial interests involved, or possibly with an axe to grind, to advocate the adoption of a world standard system of weights and measures and to try to prevent the use of the system now in use; but before deciding to follow their advice it is well to consider the disastrous effects that would follow any attempt to change from one system to another.

Industry would be demoralized. Every machine for making a bolt or nut, a tap or a die would have to be redesigned. Likewise the machines used in the making of other machines. Every specification for a locomotive or car, an automobile or power plant must be changed. Boilers and cylinders must be redesigned. Pressures in pounds per square inch must be converted to grams per square centimeter. In fact, every device entering into the construction or repair of anything of a mechanical nature must be redesigned to conform to the new standard. It is difficult to conceive which would cause the worst jumble, to make the change instantly or gradually, but it would be a physical impossibility to make such a change instantly. If the change were made gradually, during the period of transition we would be confronted with the encumbrance of two sets of standards, some parts being made by one and possibly its corresponding part by the other system. The theorist may tell you that the actual sizes need not be changed but only the terms used to designate the dimensions, but any mechanic knows the serious consequences that would arise from trying to fit one part designed by one system with another designed according to a different system, having no exact equivalent to any unit in the first system.

Moreover, every drawing, or tracing, ar blue print would have to be changed and most of them scrapped. Do you realize how serious this phase alone would be? Text books and reference books and file copies of many magazine articles would become obsolete. What a jumbled mess it would all be!

Workmen would have to be re-educated. Through years of training and experience they have become accustomed to our present system. To discard this and replace it with any other system, even though slightly superior, would greatly impair the efficiency of our shop forces for at least a generation to come. The mechanic must not only be able to use the standard system of measurements, but must be able to *think* in terms of them; otherwise we cannot expect him to greatly further the progress of industrial development.

Surely no arbitrary legislation should be enacted without the full knowledge and consent of those most vitally concerned in our industrial welfare. It is easier to scramble the eggs than to unscramble them, as politicians and railroad men have found out. We are living in an industrial age—an age wherein greater achievements have been made than in all the preceding days of history. But we are just at the beginning. Surely we should not swap horses in midstream, unless this is found to be absolutely necessary. What group of men are more vitally interested or more competent to pass on this question than your readers? What do you think about the proposition?

A Conservative.

ADVANTAGES OF STOKER FIRED LOCOMOTIVES*

Stokers a Necessity on Large Modern Power
Slack Coal or Screenings Not Economical Fuel

BY D. F. CRAWFORD
Vice-President, Locomotive Stoker Company

As there are approximately 5,000 mechanically fired locomotives in the United States, it will be of interest to consider three questions: First, what led to the introduction and continued application of locomotive stokers? Second, what has the experience gained during their development and use indicated? Third, what are the questions brought about by their introduction, which must be considered by the railway officers?

My statement to the convention of the Master Mechanics Association in 1913 contains an answer to the first question. "The development of the locomotive stoker on the Pennsylvania Lines was brought about by a desire to get more tons per train over the road. I had observed in the

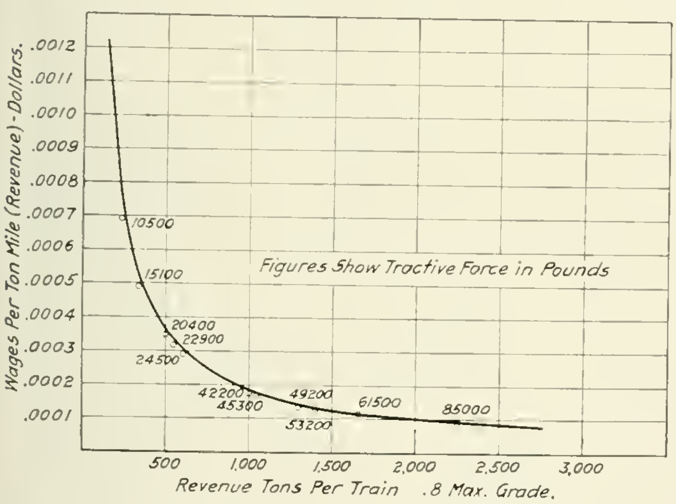


Fig. 1. Relation of Tractive Effort and Tons per Train to Wages per Ton Mile (1914 Rates Applied to Various Classes of Locomotives).

annual reports of many of the railroads, the tons of train hauled per pound of tractive power was decreasing as the engines grew large. I found that locomotives that were 20 per cent larger than other locomotives were hauling the same trains as the smaller ones and were not realizing the full 20 per cent additional tractive power that the locomotives had. The stoker problem to me was one of decreasing operating expenses by increasing the train load for each unit on which we had to pay interest and maintenance charges."

C. D. Young, after consideration of certain locomotive tests, stated: "If we use 6,000 lb. of coal, and this locomotive is capable of burning 10,000 lb. per hour, or say, if a fireman will fire 6,000 lb. per hour, and the locomotive is capable of burning 10,000 lb. with a stoker, it is then possible for you to obtain the maximum of that locomotive with the stoker, whereas you do not come to 60 per cent of the maximum output with the fireman."

These statements made in 1913 are of equal value and importance in 1919, and after all are the fundamental reasons for the existence of the locomotive stoker. While what we regard as large locomotives were in limited use before the advent of the stoker, its development and application has and will permit more full utilization of the capital invested both in the locomotive and in the permanent way through increases in tonnage and speed.

Stokers Reduce Transportation Costs

The expense of moving freight does not increase in proportion to the weight of the train, and therefore the larger the train the lower the cost per ton mile. Among the items which may be considered as decreasing in cost per ton mile in some proportion to the increase in tons per train are fuel costs, (which amount to 9.85 per cent of the total expenses) crew's wages, equipment, track structure and signal maintenance, as well as certain other fixed and operating charges.

The effect of the introduction of large locomotives on a given division operated to their capacity (which the mechanical stoker makes possible) is shown by the curve in Fig. 1, in which the crew's wages per ton mile are shown in comparison with the revenue tons per train. This indicates the results that may be expected by the use of locomotives of various capacities.

That there is a definite relation between the coal used per ton mile and the revenue tons per train, is clearly shown by the diagram in Fig. 2, which shows the coal used per ton mile for the various weights of train for nineteen railroads in various parts of the United States, this information being obtained from the annual reports of the railroads included. Notwithstanding the wide variation in traffic, operat-

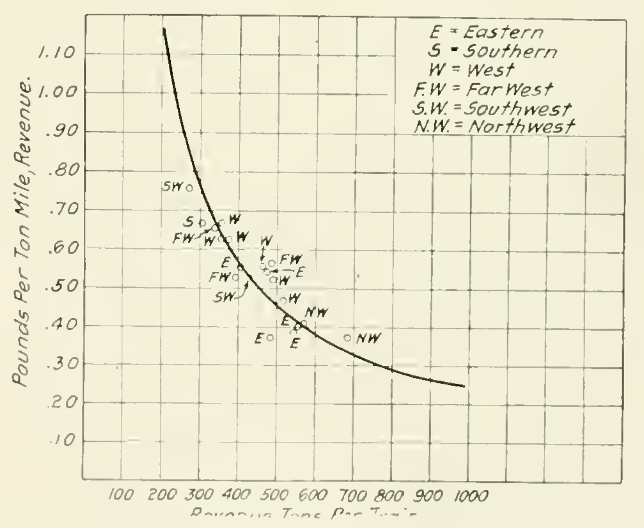


Fig. 2. Relation Between Tons per Train and Coal per Ton Mile on Typical Roads

ing, grade and equipment conditions and the quality of the fuels used, the fact that increased train loading brings a decrease in fuel per ton mile is substantiated.

It is of course difficult to state in a few words just what the use of locomotives of large capacity has meant to those making use of the transportation facilities of the country, but, by their use the average revenue tons per train in the United States was increased from 176 tons in 1888 to 357 tons in 1907, and 620 tons in 1917.

*From a paper presented before the Railway Club of Pittsburgh.

This increase in the amount of traffic moved by a train unit permitted the results disclosed below:

Year	Revenue tons per train	Receipts per ton mile	Receipts per train mile	Cost of fuel per train mile	Cost of Fuel per Ton Mile: Actual price	Cost of Fuel per Ton Mile: Equated price	Price of coal per ton
1888........	176	$0.01001	$1.76	....	......	......	....*
1907........	357	0.00759	2.71	$0.21	$0.0006	$0.0006	$1.14
1917........	620	0.00728	4.51	0.43	0.0007	0.0004	2.20†

*Information not available.
†Estimated from the price of coal in various districts as set by the Fuel Administration and is a conservative figure for the average cost to the railways.

Notwithstanding the fact that in 1917 the price of coal is shown as nearly double that in 1907, the cost of coal per ton mile was practically the same, and when the price is equated to that of 1907, the decreased cost per ton mile given shows conclusively that a smaller amount was used.

Heavy Train Loading Increases Track Capacity

Another important reason for the use of locomotives of the capacity made available by mechanical firing is the reduction of the number of units or trains required to handle a given traffic.

About five years ago query was made as to what would have been the effect if the traffic of a given railway system in the year 1912 had been moved in equipment of the capacity that had been used in 1903. Of course, in making the calculations for the reply, some factors had to be assumed; the conclusions at least indicate the propriety of the increase in capacity of both locomotives and cars.

While a larger number of the smaller locomotives and cars would be required, the fact that the number of units or trains needed so increased the traffic density that, to make the movement with the same degree of promptness as existed in the latter year, the cost of providing additional track facilities far outweighed the cost of the additional equipment. As it is only by the use of a mechanical stoker that the posssibilities of large locomotives may be realized, the information given above becomes the reason not only for their development but for their more general application.

Stokers Eliminate Necessity for Two Firemen on Large Engines

In 1903, with locomotives of about 40,000 lb. tractive force and 50 sq. ft. of grate area, from time to time complaints were received from the firemen regarding their arduous work, and frequently men left the railroad service, preferring to seek a more congenial occupation. This, of course, embarrassed the service, as at times it was difficult to obtain sufficient men to supply the demands, and I well remember the concern of those responsible on account of the large turn over and its effect on the operations. As the size of the locomotives continued to increase, the difficulties and complaints grew apace, and it may be said that the climax occurred in 1912, when the firemen in the Eastern Wage Application demanded two firemen on locomotives weighing over 200,000 lb. on the driving wheels.

During the period mentioned, several types of mechanical stokers had been built and put in service, but were regarded by both the railway officers and employees as rather more than less in the experimental stage. Nevertheless such was the confidence of some railway officers in the stoker that what may be regarded as the first commercial application of the device was made in 1910. Since that time the number applied per year has gradually increased to the total of 5,000 in use on the locomotives of at least 71 of the railroads of the United States.

Assuming that 120 lb. of coal per sq. ft. of grate per hour is required to obtain the capacity of the locomotives, the average coal rate for typical stoker-fired engines would be as follows:

Mikado	Grate 70.5 sq. ft.	Coal per hour 8,460 lb.
Santa Fe	Grate 83.0 sq. ft.	Coal per hour 9,960 lb.
Mallets	Grate 89.2 sq. ft.	Coal per hour 10,704 lb.

Evidently some locomotives of these dimensions are worked below the capacity suggested by the builders' formula of 120 lb. of coal per square foot of grate area per hour, or certainly there would be more stokers in use.

Even if half the amounts of coal per hour given above were to be fired by hand for any considerable length of time, it is probable that the limit of endurance of the men, especially during the warm seasons, would be approached and therefore the stoker will afford the required relief and will be accepted as a substitute for the second fireman so frequently requested. In fact, I am inclined to believe that in time the stoker will be preferred, as by the use of the stoker the period elapsing from employment to promotion to engineman will not be increased, which would be the case were a second fireman employed on all locomotives.

Fuel Economy and Stoker Firing

As it is evident that only the furnace efficiency is affected, whether a boiler is fired manually or mechanically, many of the tests of stoker-fired locomotives which have been made, must be disregarded, as the results obtained clearly indicate failure to differentiate between furnace, boiler and engine efficiency.

Indeed, I can only conceive of one reason why under equivalent draft, structural and adjustment conditions a manually fired furnace should show a better performance than a mechanically fired furnace. That is, that firemen might be able to more accurately distribute the fuel, supplying the fresh coal exactly to the points on the grate required, as indicated by the color of the fire, and I can only think of one reason why the mechanically fired furnace should give the better results, namely, it is unnecessary to so frequently open and close the furnace door, permitting a more uniform fire-box temperature to be maintained.

It is probable that in locomotive practice each of these theoretical advantages offsets the other, especially at combustion rates approaching the limits of manual firing, beyond which the mechanical device is superior, due to the fact that accurate distribution can no longer be made.

The equivalent evaporation per pound of coal depends on the amount of coal burned per square foot of grate per hour rather than whether the furnace is fed manually or by a mechanical device. As the stoker is applied for the sole purpose of amplifying the output of the locomotive by causing more coal to give up the power contained therein, it follows that the evaporation rate will decrease in proportion to the combustion rate obtained.

The coal consumed per gross ton mile cannot be considered an accurate measure of the difference between mechanical and manual firing, as not only are the efficiencies of the boiler and engine variable factors, but the resistance of the train as determined by the number and weight of the cars must be given consideration.

The unit ton miles, while sufficient for rough comparisons, should not be depended upon when definite information is required.

Although it is true that the pounds of coal per indicator horsepower hour, also involves the performance of the cylinders, by careful selection of the locomotives, as to similarity in engine conditions, this unit may be regarded as fairly valuable in making comparisons.

The diagram in Fig. 3 shows the results of some tests where the information obtained is compared on the last mentioned basis. It will be moted that for the higher rates of combustion, and consequently lower boiler efficiency, the curves indicate that the coal consumption per indicated horse-

power hour favors the stoker-fired locomotive, also that when superheated steam is used there is a marked difference in favor of the mechanically fired locomotive. In the latter case, however, the excellent results shown were obtained by increasing the diameter of the cylinder equal to about 10 per cent, as it was found that with the stoker this could be done on account of the ample steam supply. Indeed further experiments justified further increasing the diameter of

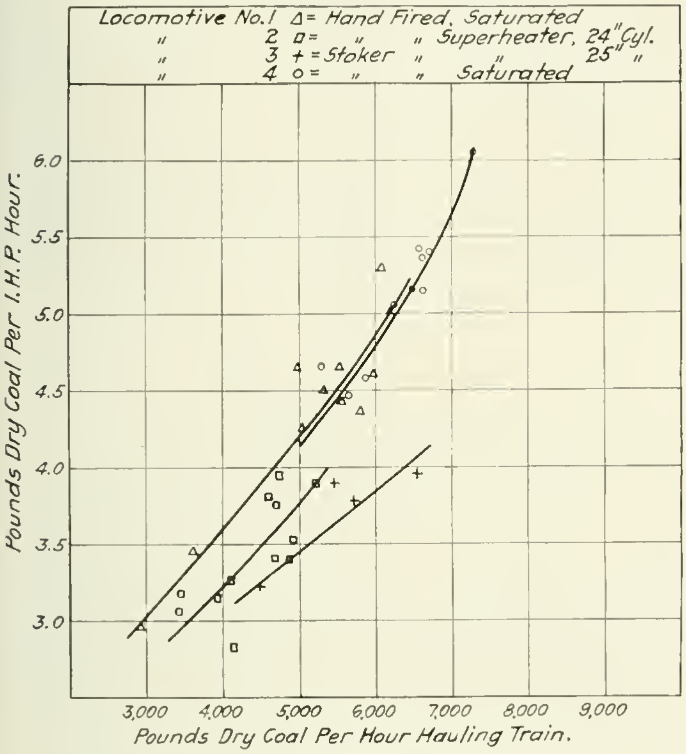


Fig. 3. Comparison of Coal Used per Indicated Horsepower Hour with Hand and Stoker Firing

the cylinders equal to about 17 per cent, with a proportionate gain in hauling capacity.

A possible increase of 17 per cent in the earnings per train mile is surely sufficient to be attractive to those responsible for the financial results of railway operations and to justify the application of a device which permits such conditions.

Fuel Economy Depends on the Fireman

How many of us have taken the trouble to ascertain the effect in coal consumption of inexperienced firemen?

The tabulation gives the results obtained on some tests made to develop the facts. It will be observed that the difference when the locomotive is doing the same work is 22 per cent.

Did it ever occur to you that there are really very few experienced stoker firemen? Why should you expect the same results from inexperienced stoker firemen that you obtain from experienced hand firemen? When tests with firemen of equal skill handling the stoker and the shovel show that more coal is being used on the mechanically fired locomotives, you may rest assured that you are getting a return for it either in increased tonnage or increased speed.

Steam Jets Increase Boiler Efficiency

Four of the six types of stokers for locomotives now in service use steam jets to project the coal into the fire-box. It has been stated that the introduction of steam into the fire-box for this purpose results in decreased evaporative efficiency. Just what has led to these statements, I am at a loss to understand, as very early in my railroad experience I was informed as to the desirability of wetting the coal to improve the combustion, and we are all familiar with the wide use of steam jets in stationary boilers, especially those equipped with certain types of mechanical stokers.

In 1912 and 1913 tests were made under the direction of the General Managers Association of Chicago to determine the effect of steam jets on the amount of smoke emitted from a locomotive, and of course one of the factors was the effect on fuel economy.

From the results of these tests published in the American Railway Master Mechanics Association, the data shown in the tabulation was obtained. The data is supplemented by

EFFECT OF STEAM JETS ON EVAPORATION

WITHOUT BRICK ARCH.

Test No.	Coal fired per hour: Total	Coal fired per hour: Sq. ft. grate	Steam through jets, lb.: Per minute	Steam through jets, lb.: Per hour	Equiv. evap. lb.	Per cent lb. steam to lb. coal
79	2,025	69.5	7.56	453.6	8.7	22.3
80	1,786	61.3	12.97	778.2	9.8	43.5
81	827	62.7	0	0	9.3	0.0
82	1,961	67.3	13.78	826.8	8.9	42.0
83	1,961	67.3	17.64	1,058.4	9.1	54.0

WITH BRICK ARCH

Test No.	Coal fired per hour: Total	Coal fired per hour: Sq. ft. grate	Steam through jets, lb.: Per minute	Steam through jets, lb.: Per hour	Equiv. evap. lb.	Per cent lb. steam to lb. coal
84	1,820	62.4	17.64	1,058.4	9.7	58.5
85	1,692	58.0	7.56	453.6	10.4	26.6
86	1,811	62.1	0	0	9.5	0.0
87	1,784	61.2	13.78	826.8	9.5	46.2

Speed—12 M. P. H.—Full throttle—25 per cent cut-off.

RESULTS OBTAINED WITH EXPERIENCED AND INEXPERIENCED FIREMEN (HAND-FIRING)

Trials of Coal—Chicago District

All Tests at 80 r. p. m.—14.66 m. p. h.—25 per cent cut-off. Length of each test, two hours

Coal	Average boiler pressure		Total coal		Total water		Steam lost at safety valve		Average smoke per cent		Brick arch
	Ex.	Inex.	Ex.	Inex.	Ex.	Inex.	Ex.	Inex.	Ex.	Inex.	
Macoupin	199.5	198.7	6,528	7,737	19,145	38,571	0	144	30	42	None
Williamson	205.8	205.4	5,762	5,568	39,727	41,482	174	678	24	20	"
Williamson	204.5	204.8	5.970	6,284	42,874	43,457	504	2,992	14	16	Arch
Sangamon	205.1	142.6	5,897	*2,887	40,077	*16,436	0	0	18	52	"
Green	206.0	204.3	5,264	6,442	41,052	41,042	154	1,344	8	25	"
Vermillion, Ill.					40,557	44,519	304	4,504	22	34	"
Vigo	204.5	203.8	5,480	6.057	39,782	40,807	532	318	20	22	"
Vermillion, Ind.	205.4	203.2	5,445	6,676	40,874	42,534	78	288	16	28	"
Sullivan	203.2	203.2	5,557	8,192	39,514	42,734	0	2,338	28	52	"
Saline	206.0	204.3	4,908	7,263	40,232	42,826	556	3,132	24	64	"
Marion	205.0	184.1	6,146	7,832	40,005	35,393	240	652	14	30	"
Total	2,044.1	2,016.3	56,824	69,306	403,762	413,365	2,542	16,390	200	334	....
Average	204.4	201.6	5,682	6,931	40,376	41,337	254	1,639	20	33.4	....
Percent. excess	....	....	....	22.0	....	....	....	541.3	....	67.0	....

Ex.—Experienced fireman. Inex.—Inexperienced fireman. * One hour test.

In the total and averages, the figures for Sangamon coal have intentionally been omitted, as two inexperienced firemen failed to maintain the boiler pressure on a one-hour test.

the following statement: "The tabulated results of the efficiency tests with Pennsylvania Gas Coal (Tests Nos. 2500-79 to 2500-87) with and without the jets are plotted. The curves show that a reduction of smoke results in an increased equivalent evaporation, and a corresponding increase in efficiency and economy with or without the brick arch, showing that the steam jet tubes make for improved combustion and economy rather than simply to "whitewash the smoke."

With this evidence before us, I do not think for the present at least we need be concerned as to the deleterious effect of using steam jets for projecting the fuel into the firebox, for if the use of as much as 1,000 lb. of steam per hour with 2,000 lb. of coal per hour does not result in reduced economy, certainly the introduction of from 300 to 500 lb. of steam per hour into a fire of 5,000 to 7,000 lb. of coal per hour will not adversely affect either the evaporation or the annual balance sheet of the railways using this arrangement.

Slack Coal Not Economical

We all appreciate that one of the arguments for the introduction of the locomotive stoker was the possibility of using the less expensive grade of coal known as screenings or slack coal, and consequently a number of stokers especially adapted for its use were installed.

Of course it was expected that the decreased cost per ton would offset the increased consumption, but the practical difficulty not only of supplying the special coal, but the necessity of carrying two kinds of coal at coaling stations, one for hand and one for stoker-fired locomotives, indicated the advantage of a stoker so arranged that it would handle run of mine or even lumps by breaking it to a suitable size on the locomotive.

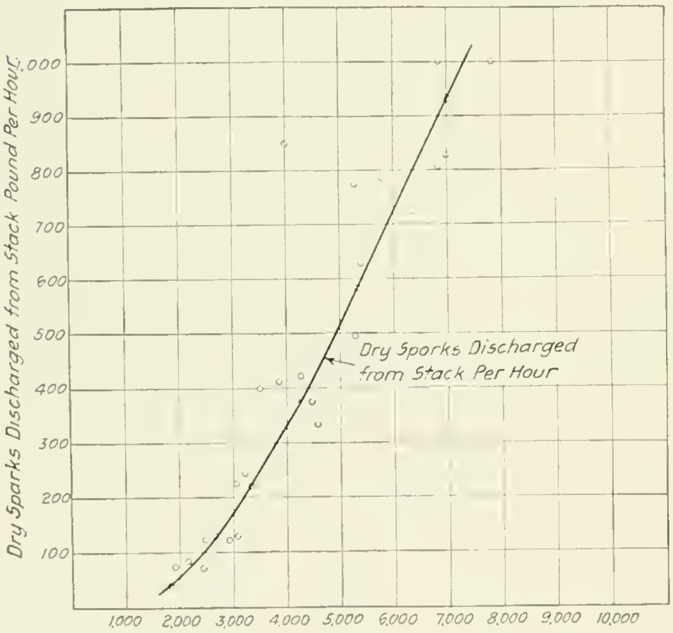


Fig. 4. Relation Between Rate of Firing and Stack Loss, Hand Firing

There is, however, a much more important reason for avoiding the use of screenings or coal of small size than the inconvenience of providing it prepared or crushing it at the coaling stations. That is, the question of quantity of fuel used.

Some comparative tests were recently made on stoker-fired locomotives. On one series of tests, coal which would pass through a two-inch screen was used, and the other series made with coal which would pass through a 6-inch, but over a 2-inch screen, in the latter case the larger lumps being reduced by the breaker in the stoker conveying mechanism. The advantage obtained in using the larger coal is apparent and amounted to over 15 per cent.

The principal cause, no doubt, of the decreased efficiency of the finer coal is the loss due to the unburned coal being thrown out of the stack. The amount of this loss of course depend upon the rate of firing and the relative fineness of the coal. The diagram in Fig. 4 shows only the relation between the stack losses and the rate of firing.

The stack losses, which run as high as 15 to 20 per cent of the coal fired, have no other relation to the method of firing except that it is the usual practice to fire at higher rates mechanically than manually.

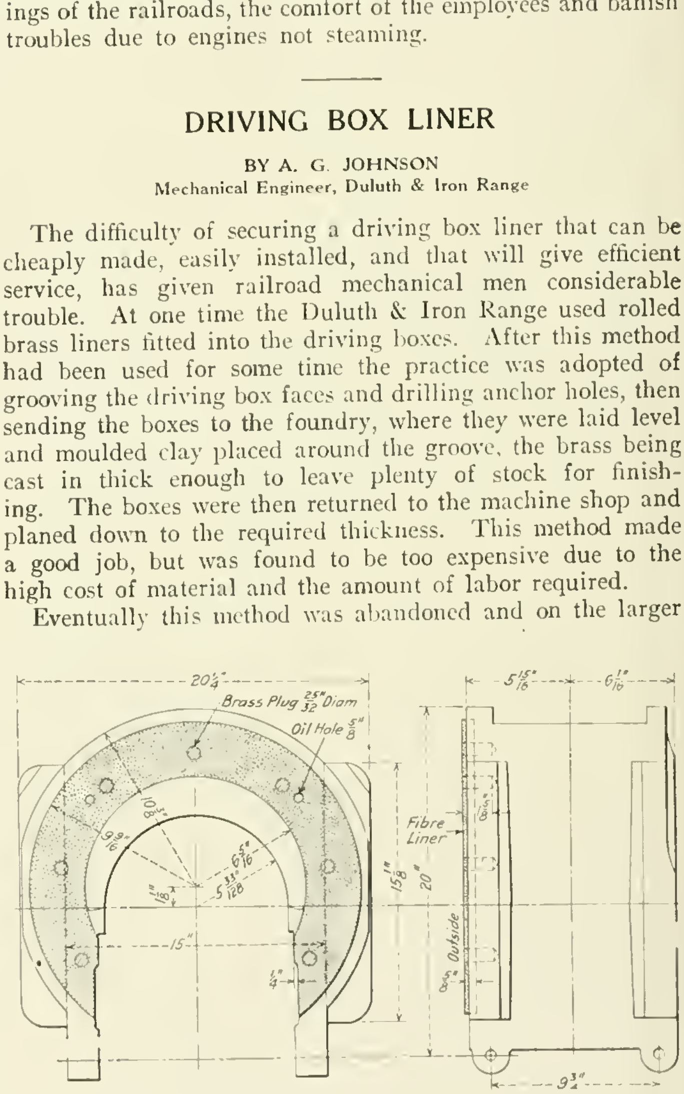
It should be borne in mind that the stoker is a mechanical device; that it will only do what a human being makes it do; that it cannot tolerate neglect. If it is properly inspected, lubricated, maintained and operated, it will add to the earnings of the railroads, the comfort of the employees and banish troubles due to engines not steaming.

DRIVING BOX LINER

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

The difficulty of securing a driving box liner that can be cheaply made, easily installed, and that will give efficient service, has given railroad mechanical men considerable trouble. At one time the Duluth & Iron Range used rolled brass liners fitted into the driving boxes. After this method had been used for some time the practice was adopted of grooving the driving box faces and drilling anchor holes, then sending the boxes to the foundry, where they were laid level and moulded clay placed around the groove, the brass being cast in thick enough to leave plenty of stock for finishing. The boxes were then returned to the machine shop and planed down to the required thickness. This method made a good job, but was found to be too expensive due to the high cost of material and the amount of labor required.

Eventually this method was abandoned and on the larger boxes, where there is stock enough, the face of the box is grooved and ¾-in. holes bored through the face. Fibre liners held in place with brass plugs driven tightly in the ¾-in. holes solved the problem. The application of these liners is shown in the drawing. The shape of the liner is laid off on the fibre sheet and sawed out on the band saw, so that it requires no extra fitting, making a very cheap job and one that gives more mileage than the brass liner, at about one-third the first cost.



The Fibre Liner Held in Place by the Brass Plugs

Scientific Development of the Locomotive*

Means of Securing Higher Efficiency in the Generation, Distribution and the Utilization of the Steam

BY JOHN E. MUHLFELD

PART II

In relation to boiler feedwater, observations and experiments indicate that any scale porous to water has little effect on boiler economy. However, such scale when dried out or hardened next to the metal by the expulsion of the carbonic acid, as usually occurs when boilers are forced, will not only become an excellent heat insulator and cause a heat loss of about 10 per cent when 1/8 in. thick, but it exposes the sheets and staybolts to overheating and "mud burning," with resulting leakage and shopping for repairs and cleaning.

In view of the increasing size of locomotive boilers and the high ratings to which they are subjected, the importance of purifying unsuitable water to prevent incrustation, corrosion, leakage and burning, as well as to eliminate delays and cost of cleaning, repairing and extra fuel consumed, cannot be overestimated.

Boiler Feedwater Purifying

When an adequate and suitable supply of boiler feedwater cannot be obtained from the usual sources, then the proper treatment of the available unsuitable water becomes necessary by settling; filtration; chemical treatment in treating plants, supply tanks or tenders; or, in the case of suspended matter and carbonates, by partial purification in a combination open and closed type of exhaust-steam feedwater heater on the locomotive.

While the supplying of suitable natural or treated boiler water to the locomotive tender is the most satisfactory and economical method, in the absence of such the tender treatment or feedwater-purification method will be an improvement over feeding the raw water into the boiler without treatment, or attempting to treat it in the boiler.

Fuel

The principal fuels now used in steam locomotives are the commercial grades of bituminous and anthracite coal and fuel oil.

Regardless of the kind of fuel now used by steam locomotives, more general attention is being given to its proper preparation for the class of service to be performed and the method of firing to be followed, before it is supplied to tenders. However, the factors of kind and size of coal and method of firing must each be carefully considered and coordinated in order to insure the best results.

Combustion

The capacity of the average steam-locomotive boiler is dependent upon the activity, temperature and radiation of combustion, which in turn are usually controlled by the limitations of combustion when fuel is burned on grates, the furnace volume and evaporating surfaces, the length of the boiler flues, tubes and bafflewall arrangement, and the draft, and not so much upon the inability of the evaporating and superheating surfaces to absorb the heat.

The combustion rate generally follows the increase in draft until about 100 lb. of bituminous and about 50 lb. of anthracite coal are burned per square foot of grate area. After this the additional coal supplied is not effectively consumed due to the difficulty in supplying sufficient air, uniformly distributed, through the grates and fuel bed to oxidize the fixed carbon and volatile matter in process of combustion without a large excess of air such as obtains when forcing takes place, and it becomes necessary to open the fire door so that combustion can be completed by the admission of air above the fuel bed.

The greatest loss in heat is that due to the heat carried off in the stack gases, sparks and cinders, which usually results in a smokebox temperature of from 500 to 750 deg. F. for the best practice. Adding to this the heat losses due to combustible in ash, vapors of combustion, carbon monoxide and otherwise, leaves an average of from 25 to 40 per cent of the heat in the fuel as fired unabsorbed by the boiler and superheater.

Where locomotives are worked at from 25 to 35 per cent cut-off and hand-fired, with a thermal efficiency of about 65 per cent for the combined boiler and superheater, the heat balance will be approximately as shown in the following table.

	Per cent
Heat absorbed by boiler	55
Heat absorbed by superheater	10
Heat loss in smoke box gases	14
Heat loss in cinders	8
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	3
Heat loss in carbon monoxide	2
Heat loss in radiation and unaccounted for	4
Total	100

However, at high rates of boiler capacity and draft, when stoker-fired coal is burned on grates the front-end and stack cinder and spark losses will run as high as from 12 to 25 per cent, the carbon monoxide from 2 to 7 per cent, and the unburned fuel from 10 to 35 per cent. With the best hand firing, when using dry bituminous coal averaging 14,400 B.t.u. and 60 per cent fixed carbon, 32 per cent volatile and 8 per cent ash, the fuel rates in Table 1 will usually obtain.

Table 1. Consumption of Dry Bituminous Coal by Locomotive with the Best Hand Firing

Total indicated horsepower of locomotive	Dry coal per i. hp.-hr.
500	2.8
750	2.7
1000	2.6
1250	2.5
1500	2.6
1750	2.8
2000	3.0
2250	3.2
2500	3.4

As the locomotive firebox, which in the best practice represents only from 7 to 10 per cent of the total boiler evaporating surface, must generate all and absorb from 30 to 40 per cent of the heat energy that is converted into drawbar horsepower, the fuel effectively consumed, not fired, is the measure of work done. Therefore the largest permissible combination of fire box and combustion-chamber volume, heating surface and grate area should be provided and equipped with an arrangement of firebrick baffle walls placed on water-circulating supports in a manner to produce long flame travel, high firebox temperature and the maximum radiant heat for absorption by the surrounding water.

With the usual limitations in firebox volume, too much

*The first section of Mr. Muhlfeld's paper, which was presented at the annual meeting of the American Society of Engineers, appeared in the January issue of the *Railway Mechanical Engineer*.

importance cannot be placed on the arrangement of heat-absorbing and radiating walls for the purpose of flame and radiant-heat propagation. Carefully conducted tests have shown that the best results are obtained from solid firebrick baffle walls and that the unburned-gas, coal-dust, spark, cinder and smoke losses are reduced with an increase in their length and gas-passage arrangement, and a saving of from 10 to 15 per cent in bituminous coal as fired is effected.

The greatest difficulty in controlling combustion occurs at high horsepowers and long cut-offs, where grates are used, and for the best results the air openings should be equal to about 50 per cent and those in the ashpans to about 15 per cent of the total grate area so that firebox temperatures of from 2,000 to 2,500 deg. F. can be obtained and the unburned solid fuel, carbon monoxide and excess air over the fuel bed reduced to the minimum.

Other important factors influencing combustion, as well as evaporation and superheating, that should receive consideration are: ratios of length to diameter of boiler flues and tubes and the spacing between them; distribution of gas area between boiler flues and tubes; the effect of closed superheater dampers on firebox draft when locomotive is not using steam; free pasage of gases through front end by elimination of unnecessary baffles, steam pipes and superheater parts; arrangement of exhaust stand and nozzle to change form of exhaust jet and produce greater entrainment of gases and improved co-ordination of exhaust jet and stack.

Boiler Water Ciculation

Water is practically a non-conductor of heat but expands when heated above 39 deg. F. and rises due to its relatively lower specific gravity. Unimpeded circulation will therefore increase its ability to take up heat, maintain greater uniformity of temperature throughout the boiler, and decrease the liability of incrustation of heat-absorbing surfaces and of priming.

In designing a boiler it is extremely desirable to secure the most rapid circulation practicable, as with high combustion rates and temperatures and the abnormal state and behavior of the water film in contact with the heating surfaces, the load on the firebox sheets is very intense, the conduction rate averaging from 75,000 to 100,000 B.t.u. per square foot of evaporating surface per hour.

Therefore, in order to avoid resistance to heat transfer, with resultant overheating of metal and reduced efficiency, a relatively high velocity of circulation and at least a rate of 125 ft. per min. in the most sluggish locality is very essential.

The average locomotive boiler, with its combination of cylindrical and box shell, water legs, staybolts and rods, flues, tubes and generally irregular design of water spaces does not present ideal water-circulation possibilities, but the enlarging of contracted spaces, increasing of water-leg, flue and tube clearances, and provision of suitable outlets from choked water pockets will not only reduce the resistance to the "slip" of the steam bubbles through the water, but will enable the accelerated action of the former to increase the velocity of the latter and thereby improve general circulation and heat-transfer results.

Heat Radiation, Convection and Conduction

The transmission of the heat of combustion produced in a locomotive boiler is by means of radiation and convection to the firebox, flue, tube and superheater heating surfaces, by conduction to the water in the boiler and the steam in the superheater, and by convection through the boiler water and the superheater-steam mass. In addition there are the direct radiation losses, which in many instances are considerable.

Heat Radiation. In a locomotive boiler the efficiency of combustion heat transfer through the firebox plates and boiler flues and tubes is from 20 to 25 per cent greater as applying to those heating surfaces directly affected when subjected to the radiant effect of the incandescent combustible and non-combustible particles which have passed through the minimum distance, than the heat-transfer efficiency when convection only is available. For example, when coal is hand or stoker-fired and burned on grates or in retorts the radiant heat is at a minimum and applies only to the heat-absorbing surfaces adjacent to the fire bed while the heat of convection is at a maximum; whereas when the coal is burned in pulverized form in suspension this condition is reversed, as is evidenced by the intense incandescent flame which obtains not only in the furnace and combustion chambers of the firebox proper, but well into the boiler flues and tubes. The locomotive boiler of the future will undoubtedly depend more largely on radiant heat.

With respect to the loss of power through radiation to the atmosphere from all parts of locomotive boilers and machinery that are generators and containers of heat and pressure—to prevent which rather indifferent efforts have as yet been put forth, as the rate at which this loss of heat extends will depend upon the difference between the temperature of the body emitting the heat and the temperature and velocity of the surrounding atmosphere, there is sufficient justification for completely and properly lagging the boiler, firebox, cylinders and heads, steam chests and all other radiating surfaces, as well as for polishing certain machinery parts, in order to reduce the dissipation of heat that now takes place through these parts from the existing steam pressures and superheat.

Heat Convection. In the locomotive boiler convection acts particularly in the transfer and diffusion of the heat in the products of combustion throughout the firebox, flues, tubes and superheater by means of the smokebox draft and in the carrying of the heat through the boiler-water mass by the currents produced by circulation. In the present locomotive boiler by far the greatest proportion of the heat is imparted to the boiler evaporating and superheater surfaces by convection.

To secure the fullest benefit from heat convection the combustion volumes and gas areas must be so co-ordinated as to establish a "velocity pressure" or "frictional" action between the gases and the heat-absorbing plates and tubes in order to increase the rate of heat transmission. Likewise must the boiler circulation be expedited in order to quickly disengage and release the steam bubbles from the water side of the same plates and tubes in the final heat transfer. The possibilities for improving heat transmission by convection in the locomotive boiler with its high water rate, *i. e.*, a boiler horsepower for an average of less than two square feet of total evaporating surface, fully justifies additional study.

Heat Conduction. In the locomotive boiler heat conduction is principally associated with the thermal conductivity of the firebox, flue, tube and superheater materials and with the accumulation of soot and scale on the fire and water or steam sides, respectively. Any increase in the rate of external conductivity, considering the present kinds and thickness of firebox, flue and tube materials as practically fixed, must be through an increase in the rate of flow of the heated gases, and this in turn means the expenditure of a greater amount of energy to pull these gases through the boiler.

However, questions as to the proper gas areas, rate of flow of gases, best sizes of flues and tubes for the maximum rate of heat transfer, and relating to like factors should be carefully analyzed in order that the highest absorptive efficiency may be obtained, not only with the high but also with the low gas temperatures. While there is no difficulty in now obtaining a boiler horsepower from each 1½ to 2 sq. ft. of total evaporating surface, whatever further improvement can be made in this direction will provide just that much more margin of boiler over cylinder horsepower requirements and produce a corresponding gain in efficiency.

Steam Generation

Efficient absorption of heat for the generation of steam in the modern locomotive boiler can be more readily provided for than can suitable feedwater, effective boiler-water circulation, efficient combustion or the maximum pounds of dry saturated steam per hour, which latter is a fundamental requirement.

In present locomotive operation the quality of the steam, *i. e.*, the percentage of vapor in a mixture of vapor and water, is one of the most important and least-referred-to factors in road and laboratory test reports, particularly as the average modern locomotive boiler is notorious for delivering saturated steam to the superheater or to the steam pipes with a high percentage of entrained moisture. This is due largely to the relatively small steam space in the boiler, the close proximity of the water level to the throttle valve and the backlash due to the firebox tube sheet, and also to the fact that the most rapid movement of the steam is next to the throttle valve so that any water coming near it is immediately entrained, due to the high velocity.

Road tests recently conducted on modern Mikado types of locomotives showed an average quality of from 94.7 to 96.3 per cent for the saturated steam as delivered to the superheater, indicating from 5.3 to 4.7 per cent of moisture, which is valueless so far as its power for doing work is concerned but which greatly increases the work to be performed by the superheater by throwing upon it work which should properly be done in the boiler.

The delivery of dry saturated steam from the boiler is an item that has been given but little consideration in steam-locomotive practice, the principal idea having been to produce evaporating capacity and depend upon the superheater to perform auxiliary boiler functions. Many changes can and should be made to improve this condition.

Steam Pressure Increase

One of the greatest and simplest improvements to be made in the steam locomotive can be effected by an increase in the boiler pressure in combination with greater quantity and better quality of saturated-steam production, higher and more uniform superheat, and compounding.

While the loss in steam pressure between the boiler and the valve chests of saturated-steam locomotives is considerable, this loss is substantially increased in a superheated-steam locomotive. Tests have indicated that the loss in boiler pressure at the valve chests when working at low rates of speed and cut-off will be about 5 per cent, at medium rates about 10 per cent, and at high rates about 15 per cent.

During recent years stationary-boiler engineers have not only determined upon their efficiency but have inaugurated the use of relatively high steam pressures, and with the urgent necessity for keeping the cylinders as small in diameter and the reciprocating and revolving parts as light as practicable, there would appear to be no good reason for not now utilizing saturated steam of 350-lb. pressure, which, in combination with 300 deg. F. of superheat, should provide, in addition to the many other advantages, a much greater opportunity for economy in power generation.

Steam Superheating

The use of superheated steam has done more to increase sustained hauling power, reduce fuel and water consumption and increase thermal efficiency than any of the other means and methods that have been generally adopted on the steam locomotive since its introduction, either singly or in combination. Sustained hauling capacity is increased, due to the longer cut-off possible at comparative speeds and fuel and water economy result from the elimination of cylinder condensation, the increase in efficiency being progressive and in proportion to the amount of superheat up to the point at which the exhaust steam begins to show superheat.

With the average superheat now used, from 175 to 250 deg. F., the drawbar pull at a speed of 20 miles per hour is increased about 15 per cent; and at 50 miles per hour about 40 per cent; and, due to the combination of superheat, larger diameter of cylinders and reduced cylinder back pressure, resulting from the use of superheated steam, it is possible to increase train tonnage about 30 per cent at speeds of about 30 miles per hour.

In the best existing steam-locomotive practice the superheat generally increases with the cut-off up to 50 per cent cut off, beyond which there is usually a falling off in the superheat. Furthermore, with short cut-off a fair water rate, *i. e.*, about 19 lb. per i.hp., can be maintained; but if the cut-off at the same speed is increased to over 50 per cent the superheat must be increased to about 300 deg. F. in order to maintain the same water rate, or otherwise, for example, at 67 per cent cut-off, the steam consumption will increase to 21 lb. or more per i.hp. This for the reason that as the amount of superheat is increased the range of temperature in the cylinder during the stroke of the piston is decreased, until with sufficient superheat the changes in temperature cease entirely.

While the increased superheat results in a greater number of B.t.u. being exhausted from the cylinder, any such loss of a marked degree is more than offset by the smaller amount of heat exhausted per stroke, due to the fewer B.t.u. admitted to the cylinder per stroke at a given cut-off.

The use of highly superheated steam results in a saving of about 35 per cent of the total water evaporation per unit of power and in from 10 to 45 per cent saving in fuel, when using steam, depending upon the power output.

Existing fire-tube superheaters produce the maximum superheat only when the locomotive is forced to its boiler capacity, whereas the maximum economy is more desirable when the locomotive is working under average conditions at economical cut-offs and when the superheater should give as nearly as possible a uniform degree of high superheat under all conditions of working, regardless of the boiler evaporation. For example, if the degree of superheat obtainable at speeds of 50 miles per hour with 50 per cent cut-off could be obtained at 25 per cent cut-off, a water rate of considerably less than 15 lb. could be obtained, as compared with existing rates of about 19 lb. Therefore, as the present limitation in the hauling power of the modern superheated-steam locomotive is the capacity of the boiler to produce continuously sufficient dry saturated steam of high pressure and of the superheater to maintain a uniform high degree of superheat, the possibility of improving it by means of average higher boiler pressures and superheat temperatures and better utilization of fuel, steam and waste heat, in combination with radical changes in the design and arrangement of the boiler and superheat equipment and in the saturated- and superheater-steam connections, offers one of the greatest opportunities to increase efficiency and economy. This applies particularly to the larger locomotives, many of which consume more fuel and water and do less work than the small locomotives of the same general design and equipment.

The proposed changes, while applying especially to the production of greater efficiency at economical cut-offs for maximum power and speed, would also improve the maintenance and operation of superheaters, boilers, flues, front ends, valves, cylinders, and exhaust nozzles and provide for the better equalization of a lower draft through the flues and tubes, lower front-end temperatures, less throwing of smoke, sparks and cinders, and lower cylinder back pressure, all of which would reduce loss of power, fuel consumption and wear and tear on machinery.

Some of the particular troubles reflected in both maintenance and operation, due to the existing, generally used boiler and superheater equipment, may be stated as follows:

a Air leaks around outside steam pipes where they pass through the front ends, resulting in steam failures, burning out of front ends, reduction in the size of exhaust nozzles for the purpose of making engines steam, and increased water and fuel consumption. *b* Joints between superheater units and the saturated and superheated chambers of the headers leaking, and the cutting out of the units at the neck, between the ball joint and the tube. *c* Too little water and steam space over top of firebox and combustion-chamber sheets and flues, particularly on grades and curves, contributing to lower superheat temperature and cylinder efficiency, and to superheater-unit tubes distorting due to entrained water being carried over with the saturated steam from the boiler to the superheater, causing obstructions in and damage to superheater tubes and obstructions at the header. *d* Extreme losses in steam pressure between boiler and steam chests. *e* Boiler flues clogging, due to ash and cinders packing in around return bends and centering clamps and tubes.

Some of the points to be considered in correcting existing deficiencies may be stated as follows:

Steam Temperatures. The steam temperature should be uniform for the variable speeds and capacities of operation. At the present time high temperatures obtain only at high speeds and capacities. A minimum temperature of 650 deg. F. quickly after starting, and of 700 deg. at maximum power and speed, would be much more effective and economical. For example, a locomotive equipped for generating 350 lb. steam pressure and 300 deg. superheat, representing a total temperature of about 736.4 deg. F., will, as compared with one using 200 lb. steam pressure and 300 deg. superheat—representing a total temperature of about 687.9 deg. F., require an increase of only 18 B. t.u., or 1.3 per cent in total heat in the steam, and an increase of only 48.5 deg., or 7.05 per cent in the temperature of the steam to produce an increase of 150 lb., or 75 per cent in the steam pressure.

Dome or Steam Outlet. This should be fitted with baffles for the purpose of reducing liability of priming and entrainment of water with saturated steam.

Saturated-Steam Delivery Pipe. This should be located outside of the boiler and be of adequate cross-sectional area to reduce steam-pressure losses.

Steam Trap or Separator. A steam trap or separator should be installed between the saturated-steam delivery pipe and the superheated saturated-steam chamber for the purpose of further eliminating moisture and condensation from the superheated units and also as a re-evaporation chamber.

Superheater Header or Saturated- and Superheated-Steam Chambers should be removed from the interior of the front end.

Superheater Units should consist of not more than two tubes per boiler flue and should be of such design and arrangement as will admit of location close to the top of the flue, in order to permit free passage for cinder and ash and cleaning of flues.

Unit Joints to Saturated- and Superheated-Steam Chambers. Unit joints should be removed from the direct path of gases and cinders so as to avoid cutting out, and should be supported in a positive, equalized and flexibly yielding manner to prevent leakage due to the loosening of one joint causing the loosening of another and so that the joint bolts can be tightened at the top of the header castings.

Superheater Dampers. These should be kept in good operating condition, so that when the steam ceases to flow through the superheater units the products of combustion will stop flowing through the superheater flues, particularly when drifting at high speeds.

Steam Delivery Pipes from the Superheated-Steam Chamber should be made of adequate cross-sectional area to reduce steam-pressure losses and removed from the interior of the front end, so that no joint where they pass through the front end will be necessary.

Automatic Saturated-Steam Supply When Drifting. This is essential to eliminate the human element and insure a proper supply of saturated steam with the superheated steam just before the throttle closes and continuously thereafter. A jet of saturated steam should also be supplied to the exhaust nozzle to neutralize the gases ordinarily drawn through the same into the valve chests and cylinders.

Modern types of locomotives have developed at low speed 3,000 i.hp. and at high speed 3,200 i.hp., and comparative average water rates through the complete range of the effective capacity of the locomotive, with piston speeds of from 600 to 1,000 ft. per min., have been obtained, as shown in Table 2. At piston speeds of less than 600 ft. per min. the water rate of the double-expansion saturated-steam locomotive will approximate that of the single-expansion superheated-steam locomotive.

TABLE 2—COMPARATIVE WATER RATES OF LOCOMOTIVES WHEN USING SATURATED AND SUPERHEATED STEAM

Cylinders	Steam	Water rate per i.h.p.-hr., lb.
Single expansion	Superheated	16 to 20
Single expansion	Saturated	24 to 29
Double expansion	Superheated	15 to 18
Double expansion	Saturated	19 to 22

Compounding. With the exception of the Mallet articulated type of compounding, the multiple-expansion system of steam utilization, which has been so successful in marine and stationary practice, has not made the progress in this country that it has in Europe.

The failure of various types of cross, four-cylinder, four-cylinder balanced and tandem double-expansion locomotives, introduced from 25 to 15 years ago, to produce the predicted economy was due largely to factors of indifferent design, low boiler pressure, excessive condensation, lack of proper maintenance and operation, poor fuel and road failures. Clearance limitations also restricted the size and arrangement of the low-pressure cylinders, while at the same time the single-expansion-cylinder superheated-steam locomotives gave opportunity for greater hauling capacity and economy.

The three-cylinder compound has frequently been advocated owing to the allowable reduced cylinder diameters and piston thrusts and a more uniform turning moment, but its use has been deferred owing to central main-rod and axle complications.

There is no doubt but that a properly designed superheated cross-compound locomotive embodies many advantageous features, such as greater starting and hauling capacity per unit of weight, less evaporating surface per indicated horsepower, reduced fuel and water consumption and less boiler repairs, and that it will return to favor for freight service in combination with higher boiler pressures and superheat, due to the necessity for greater drawbar pull and horsepower and for utilizing all superheat before its final exhaust.

By eliminating the disadvantages of the outside valve gears now in use and adding certain improvements for the purpose of increasing the ratio of expansion and shortening the ratio of compression, the tractive effort can be increased at least 10 per cent at all points of cut-off and the fuel consumption reduced 5 per cent through ability to develop the same drawbar pull with a shorter cut-off. Such a change will add greatly to the efficiency of the steam locomotive.

Where compound cylinders are used a steam expansion regulator should be incorporated with the motion gear to effect the automatic independent adjustment of the cut-off for each of the high and low-pressure cylinders for the purpose of obtaining certain cylinder ratios, and at the same time bring the cut-off in harmony at the center of the quadrant. By this means the ratio between the high and low-pressure cylinders, which, for example, should properly be 1 to 3 at starting, can be brought to 1 to 4 at cut-off, thereby

insuring easy exit of the exhaust steam from the low-pressure cylinder and at the same time automatically distributing the work properly between the two cylinders at speed. In this way a compound locomotive of the Mallet articulated type can be made to develop at least 55 per cent of its rated tractive power at a speed of from 8 to 10 miles per hour, when operating at 25 miles per hour, and there will be a gain in tractive power of about 15 per cent at 25, and of about 10 per cent at 30 miles per hour. In fact, a drop in the drawbar pull in a Mallet articulated compound locomotive on account of speed should not materially increase beyond that of a single-expansion engine.

Cylinder Clearance. The inauguration of the use of the inside-admission piston valve and of superheated steam has brought with it the wasteful effects of larger cylinder clearance, due principally to the use of a valve of too large diameter and an indifferent design of valve chest and ports in combination with the cylinder castings. To somewhat overcome this trouble the piston valves were increased in length, with subsequent breakage of castings through the vertical ports, particularly as the result of water from condensation and unstayed flat surfaces.

The use of smaller-diameter piston valves located close to the cylinder and connected with properly designed expanding steam ports will, in combination with improved material and workmanship, correct these generally existing deficiencies.

Cylinder Back Pressure. About 75 per cent of the cylinder back pressure is due to the use of the exhaust steam to produce draft for combustion, evaporation and superheat. Assuming that for every 100 hp. in steam used only 60 per cent is utilized in producing actual tractive power, then 40 per cent is wasted through the exhaust, of which 75 per cent is chargeable to steam and superheat generation.

Much remains to be done in the way of enlarging exhaust-steam openings from the cylinder to the atmosphere and in reducing existing sharp turns, cramped passages and obstructions to the free passage of steam through them; and also in the development of an exhaust stand and nozzle that will combine the advantages of the single and double types. It has been found that by enlarging a 5½-in. diameter exhaust nozzle to 5¾ in., or about 9.3 per cent in area, fuel consumptions have decreased from 15 to 20 per cent, depending upon fuel and weather conditions, and that the locomotive efficiency has been increased from 10 to 15 per cent, depending upon cut-off and speed.

Valves and Cylinders. Inside-admission piston valves, although inherently deficient with respect to water and compression-relieving capacity, have many advantages, particularly for superheated steam, and the application of double-ported valves for low-pressure cylinders has worked out satisfactorily.

Various tests and many years' experience have demonstrated through the better use of steam and the resulting reduction of jerking, pulling and stresses on valve stem and gear, unbalanced pressure, frictional contact, valve and bushing wear, leakage and lubrication, the practical advantages of a minimum diameter and weight of valve with the circumference no greater than the length of a slide-valve port and with every inch of bushing port made effective and designed in conformity with the well-known principles governing the flow of gases so as to eliminate eddies and baffling in the steam flow which occurs in the passages between valve and cylinder.

In addition to reducing the weight of a valve by reducing its diameter, it can be further lightened by using a smaller spool, as experience has proven that with simple cylinders an area of opening through the valve body equal to one-half the area of a single exhaust-nozzle orifice is sufficient to obviate the hammering of the exhaust steam on the valve ends. With cross-compound cylinders the conditions are even more favorable, due to the receiver pressure. Furthermore, there is still a possibility of considerably reducing weight in bull-ring and follower designs, which will further reduce the stresses in valve rods and gears that have been found to increase with the speed, cut-off and weight of valve.

There is also considerable opportunity to improve packing rings by locking and putting them in absolute steam balance, preventing exhaust rings from collapsing under compression or being forced from grooves into ports between bridges, and stopping leakage of live steam to the exhaust side of the valve. Extended rods and carriers for the front ends of both valves and pistons have also been found essential to the best results. Two refined-gray-iron packing rings should be sufficient for all pistons, and two-piece one-ring piston and valve-rod packing of a suitable aluminum alloy should be satisfactory. Wherever possible the center line of each cylinder, under normal working condition, should be in horizontal alignment with the centers of the driving axles. All cylinders should be equipped with suitable types of by-pass valves.

Piston Speeds. Frequent errors have been made in not properly proportioning the driver-wheel diameter and stroke of the piston. Slow speed and high ratios of expansion are factors particularly favorable to superheated steam, and piston speeds of from 700 to 1,000 ft. per min. will insure the best results.

Waste-Heat Distribution and Utilization

As a reasonable estimate would show that 40 per cent of the heat in the steam and in the products of combustion is exhausted from the stack, any considerable part of this heat that can be reclaimed for preheating boiler feedwater will add greatly to the overall efficiency of the locomotive and to the saving in fuel. The principal means through which to accomplish this saving, in a practical way, are exhaust-steam heaters and flue-gas economizers, both of which can be readily adapted to a modern steam locomotive.

Exhaust-Steam Heaters. With the many steam-using auxiliaries, such as those for air compressing, boiler feeding, valve-gear operating and electric lighting, which operate when the locomotive is standing, drifting or working, a combination open and closed type of feedwater heater and purifier for the utilization of the exhaust steam from these auxiliaries, supplemented if necessary by steam from the main engine's exhaust, should receive prompt consideration.

From actual service tests of closed types of heaters, made on modern superheated-steam locomotives, using a portion of the main-engine exhaust steam only, it has been found that a feedwater temperature approximating 240 deg. F., or within 15 deg. of the exhaust-steam temperature, can be obtained without interfering with the draft required for maximum steam and superheat generation.

Flue-Gas Economizers. Owing to the high rate of combustion and evaporation and in the process of superheating, much heat is usually wasted, as the gases from which the steam receives its heat must be hotter than the steam itself. The higher the steam pressure the less is the average difference in temperature between the gases of combustion and the contents of the boiler, therefore the slower the transmission of heat the greater the work of the economizer may be. Likewise the lower the efficiency of the boiler will be if it is not supplemented by an economizer.

An economizer will heat the feedwater to a higher temperature than an exhaust-steam heater and will recover most of the waste heat resulting from high steam pressure and high superheat, as it is able to recover low-temperature heat that has escaped from the boiler evaporating or superheater surfaces because the average temperature of the feedwater within the economizer, which should, if practicable, be

brought up to the boiler evaporating temperature, is much lower than the temperature of the water in the boiler.

As locomotive smokebox superheaters, now obsolete, have demonstrated that 50 deg. of superheat may be obtained from flue gases at 600 deg. F., there should be no difficulty in devising a locomotive economizer that will produce very effective results, in combination with high boiler pressures, superheat and draft, without baffling the boiler draft and evaporating capacity. In fact, with an average boiler efficiency of 60 per cent and an economizer efficiency of 50 per cent, the possibility of recovering from 25 to 50 per cent of the stack gas loses and thereby increasing the thermal efficiency of the entire unit is well within the limits of possibility.

DISCUSSION

F. J. Cole (American Locomotive Company) took issue with many of Mr. Muhlfeld's statements. He cited the fact that a modern locomotive will produce a horsepower-hour on less than two pounds of coal to prove that the locomotive is an economical power plant. He stated that the usual design of locomotive boiler is not suited for a pressure of 350 lb. and much remained to be done in the way of designing boilers to safely operate under high pressures. Mr. Cole pointed out that by the use of trailing wheels the boiler design is improved and higher efficiency secured. He thought it doubtful whether increased water volume would add to the efficiency of the boiler, but pointed out that attention should be given to details of domes and throttle valves to prevent water being carried over into the dry pipe. He also stated that while the high cost of coal undoubtedly justified the introduction of devices that increase capacity and economy, the greater maintenance cost resulting from their use must be considered in judging the relative merits of specific devices.

Clement F. Street (Locomotive Stoker Company) questioned the data Mr. Muhlfeld submitted regarding the cost of electric operation and defended the performance of locomotive stokers.

H. B. Oatley (Locomotive Superheater Company) stated that the program of improvement laid out by Mr. Muhlfeld was not entirely practical as regards economy, though almost ideal from the standpoint of the generation and utilization of steam He stated that with the proper design of boiler a steam pressure of 500 lb. would prove both safe and economical, and stated that condensing operation was not beyond the realm of possibility. Mr. Oatley also expressed the belief that the present method of transmitting power would be superseded by an improved type of construction that would result in the elimination of considerable unbalanced reciprocating and rotating weight and consequently in less rapid deterioration of the rail, the rail bed and the driving mechanisms.

Otto S. Beyer, Jr., stated that the possibilities for economy of the super-power plant, located in the coal district itself and doing away with fuel haulage, should be considered. He believed that speed in railway operation, which in turn would mean faster locomotives, will be required more and more in the future.

E. B. Katte (New York Central) disagreed with Mr. Muhlfeld's conclusions regarding the obejctions to electrification. He stated that experience had proved that the capital cost was not prohibitive, that electric operation had been demonstrated efficient, economical and reliable for every class of service. He pointed out that electrification increased the capacity of tracks approximately 30 per cent and that while the first cost of the electric installation was higher than for a steam operated road, the operating cost was less with the electric equipment.

George Gibbs (Gibbs & Hill) stated that the author was mistaken in his belief that electric traction had not given the desired results. More money had been made for the stockholders by reduced operating expenses or by producing new business either by more attractive or more reliable service or by an increase in the capacity of the railway's facilities as a whole.

Mr. Muhlfeld in closing said that in the boiler being designed for higher pressures the largest diameter of the shell, which was made of 1 1/4-in. plates, was 68 in. This was about as large a boiler as could be handled at present by locomotive builders. Mr. Oatley had referred to 500 lb. pressure. What had limited him in his argument in the paper to 350 lb. was the cylinder temperature, not boiler troubles, and tests made during the past three years had shown that a higher temperature than 750 deg. F would be one that would destroy the cylinders, as well as the packing and bushings.

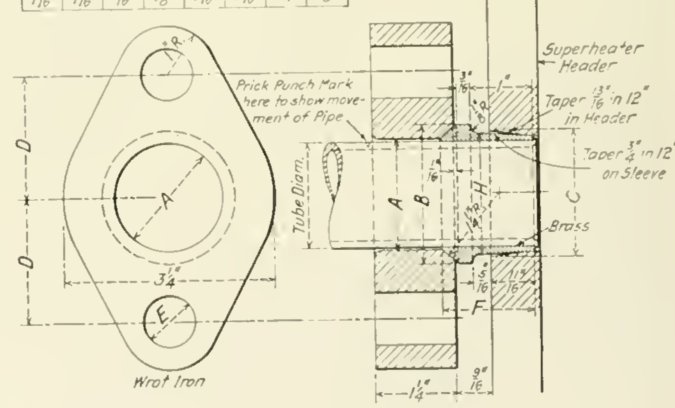
In the matter of burning coal, to which Mr. Street had referred, he would say that during the past five years he had made numerous tests of the cinders taken from the back of a stoker-fired locomotive and from accumulations in small boxes placed on top of a freight train, and had found that in nearly every case they were unconsumed particles of fuel. The coal was being put through the boiler but was not being burned.

In regard to questions propounded by James H. S. Bates and William H. Wood, he would say in reply to the former that the steam turbine had not as yet been adapted to the locomotive, and to the latter that fireboxes with flexible stays were being eliminated.

TAPERED JOINTS FOR SUPERHEATER UNITS

In superheaters with spherical ground joints a high tension on the bolts securing the elements is necessary to avoid leaks. An interesting type of joint designed to overcome this difficulty, which has been introduced on the Great Northern, is shown in the drawing below. The superheater units have brass sleeves, fitting tightly over the tubes. After the sleeves are in place the ends of the elements are peened out slightly

H	F	E	D	C	B	A	Tube Diam.
1 1/2"	1 3/8"	15/16"	1 7/8"	1 1/2"	1 7/8"	1 7/16"	1 5/16"
1 5/8"	1 7/16"	15/16"	1 7/8"	1 5/8"	2 1/16"	1 9/16"	1 7/16"
1 13/16"	1 7/16"	15/16"	1 7/8"	1 13/16"	2 3/16"	1 3/4"	1 5/8"



Type of Joint Used On Emerson-Yoerg Superheater

to hold them securely. The end of the sleeve is finished with a taper of 3/4 in. in 12 in. while the opening in the header into which the sleeve is fitted has a taper of 13/16 in. in 12 in. This slight difference in the taper causes a powerful wedging action when the gland is drawn up and insures a steam tight joint. This type of sleeve has been used with excellent results on the Emerson-Yoerg superheater.

What Is Wrong With Railroad Management?

Complication but no System; Neglect by Railway Officers Causes Loss of Interest by the Workmen

BY FRANK ROBERTS

Efficient transportation depends in part upon well-kept motive power. The physical condition of motive power to effectively do its work depends upon several factors. First, an efficient, able, interested, co-operative official organization; and, second, a well managed, fully stocked and properly equipped enginehouse. The third is further removed from the daily routine, or from direct touch and actual operation. The general locomotive repair shops are truly the general hospitals, in which all real operating disorders are corrected, the source of all emergency heavy repair parts, and the place where the real upkeep is handled.

I make this introduction for the purpose of coming down to the conditions prevailing in railroad repair shops and to show the methods that are tolerated. Extravagant inefficiency, which would ruin Henry Ford if introduced into his shops, is overlooked in railroad shops and covered up with an annual appropriation and forgotten, the same as a wealthy parent makes an allowance to a boy at college and then forgets it. We get some idea of this waste as we read how Uncle Sam lost $1,000,000 a day while operating our railroads.

From what appears in our daily papers, or what we hear on the street, or observe from the car window, a person gains but little understanding of the necessity for an auxiliary such as a general repair shop for motive power.

> **Inefficiency of railway shop organizations due to lack of proper tools and of interdepartmental co-operation, resulting in loss of time and money.**

This lack of understanding and appreciation on the part of the public is unfortunate and in about the same spirit, it would appear, the railway officers try to forget the shops. The only token that the workers in these shops have of their employer's interest in their welfare is a visit once a week by the paymaster, and perhaps late in the autumn a few workers will drop in unexpectedly and repair some of the worst leaks in the roof over their head, replace missing window lights or otherwise protect them against the approaching cold of winter. This may seem a little unfair to an outsider, but to the workmen themselves the impression is that, with the above mentioned duties performed, the officials have discharged their obligations, and locomotives should always be in fit working order to deliver their allotted ton-miles of service without the sacrifice of a single B.t.u. of heat or mechanical energy through inefficiency resulting from any possible question of repair.

The fact is, about eight per cent of the total investment of a railroad is in locomotives; that is, if the road has been properly financed. Some we know have had their capitalization so doctored up that if all the facts were generally known we would be prone to consider the venture as below water, and a marine rather than an overland proposition. This eight per cent investment unfortunately is like the dresses women wear—more expensive in the first cost; much more care and trouble to maintain and not nearly as serviceable as they were 20 years ago. For example, 20 years ago we could purchase a good locomotive for $15,000, and today a modern locomotive costs anywhere from $50,000 to $100,000. One railroad purchased some Baldwin "hogs" some 20 years ago, and it was usual in rush seasons for these locomotives, after making their daily run, to come into the freight yard with a train, disconnect, run on the turntable, head about, have the fires cleaned on the ashpit, the tank filled with water, the sand box and coal pocket filled, a new crew on hand who immediately advanced to the yard, attached to a train and made the return trip. These engines have operated under such conditions for a week at a time without ever seeing the inside of an enginehouse. The only repairs or attention they received were made by the engineman and fireman in charge. But that was during the days when everybody knew the division superintendent and all had a semblance of interest in their work. Those were days when a man was allowed to take pride in his work, and he knew that his days with the road were determined by faithful services. At that time common sense kept each worker's ambition up. Unusual ability gave unusual results, and promotion came to the faithful. If trouble came it was local and settled in a man to man fashion, and the public had all their trains during the controversy.

Complication but No System in Handling Work

Conditions have changed, not only in the matter of human relations, but equally noticeably in the motive power. Our locomotives have become so overgrown that they shake themselves apart on the road, and it is not safe to continue them in service over 100 miles. This may be news to some people who may imagine that the same locomotive draws their train from Boston to Chicago, but if they will observe the number on the cab as they board the train at South Station, Boston, and observe operations at Springfield, again at Albany and so on at about every one hundred miles, they will see a change of locomotives. The locomotive thus relieved is run into the roundhouse and a crew of men goes over it, making the repairs that the engineman's report calls for, usually considerable, including anything from a mis-set safety valve to a leaky set of boiler tubes. In addition to this there is a staff of inspectors who examine for their special parts. One looks for flat wheels or sharp tires, another for hot journals, another to test the air brakes, lubricators, etc., until every part is thoroughly inspected. If the piston rod of the air pump was leaking in olden times the engineman took about five minutes and repaired it—now he is not allowed to. He must make a report and a special workman is sent out to do the work. He may or may not make a good job of it, but it makes no difference, because another engineman will take the locomotive out on the next trip, and the air pump man in the roundhouse at the other end will give it a try.

An inspector may report a nut off a binder bolt. The machinist finally reads his work report, asks the storekeeper what size bolt locomotive No. 1100 has on her left main binder. He thinks it is a 1-in., his friend is of the opinion that it is 7/8-in., and his helper declares it is either 1 1/8-in. or 1 1/4-in. because they put some on No. 900 last week. "All right! To be sure, we will take one of each, 7/8, 1, 1 1/8, or 1 1/4-in. to save a trip out to find out just what size it is." This plan certainly saves steps, and they proceed into the enginehouse to locomotive No. 1100, and sure enough the

helper was right, it is 1 1/8-in., and on the nut goes. But it is a waste of time and strength to take those other nuts back to the stock room, and down the pit they go. This shows the modern spirit, and if you are not yet convinced let me state that on one division, where there are only 300 locomotives, the firemen used 2,400 fire hooks in six months, or an average of a hook on each locomotive in 23 days. Where do they go? Of brakeman's lanterns 5,000 a year. Where do they go?

Present day locomotives cannot continue in service even in an emergency without considerable repairing after each trip of about 100 miles. The element of continuous service is a lost art, as well as the spirit of service that came with a day's work years ago.

Inefficient Methods for General Repairs

All the repairs thus far referred to are classified as enginehouse work. After a locomotive has made from 50,000 to 75,000 miles, usually in from 10 months to a year, it is taken out of service and given a general overhauling in the shop. Also all locomotives that have had a serious breakdown or have been in a wreck find their way back to the shop. They are dismantled or stripped, all the parts thoroughly cleaned, broken parts welded or replaced with new, all springs are heated and restored to the original dimensions and again tempered, valve gear and side rods annealed and new bushings applied, the cylinders and steam chests rebored, or perhaps new bushings applied. The piston and valve stem packing is repaired or replaced, the driving boxes equipped with new brasses and liners, the axles and crank pins turned and trued, the driver wheels turned or perhaps new tires put on, the driving box shoes and wedges refitted or perhaps replaced with a new set and the frames repaired if they are worn or cracked. The boiler must be thoroughly inspected and tested, the flues removed, cleaned and returned and welded in place. The safety valves, injectors, pneumatic firedoors, gages and gage glasses, the air brakes, valves and pump, power reverse gear, electric light generator, the superheater units, tender tank, trucks and draw gear all require a thorough rebuilding. So much for the extent and nature of repairs which are completed with the locomotive ready for trial and return to service, from which she has been withdrawn for a period varying from 16 to 30 days.

The important connection with all this is the way in which it is handled and the lack of co-operation and interest among the workmen, due in a large part to official neglect and the results of present day tendencies. The peculiar thing about railroad organizations is the fact that no man or any particular job nor any particular person can get any recognition, either for his ideas, the need for necessary material, or is provided with tools or adequate shop facilities to go ahead efficiently. If a man asks his gang leader for a new file or a piece of belting for his lathe he is told that the storekeeper is out of that material. The storekeeper informs the shop foreman that the purchasing agent has had his requisition for three months and has not placed the order, or else he is told that his letter of certain date requests that he hold back on certain items for some months, or under conditions now existing he will have to ask him to cut his stores down another 25 per cent, etc., etc. Perhaps the general foreman has been drawn in and he, through the division master mechanic and the superintendent of motive power, has learned from the general superintendent that he informed the purchasing agent to hold up purchasing anything further until January 1, because the federal authorities were expecting to turn the roads back. All this time the man on the lathe is wondering how he is to do his work, and as a natural result about all he is doing is to keep his time card filled out each day, draw 72 cents per hour, and report to his fellow workman about the loss that the road is experiencing because of lack of support and interest in the shop on the part of the officials of the company.

Antiquated Tools Cause Loss of Time and Money

I know of a case where it was proved that an improved piston packing ring gave a good many thousand miles of increase in service, over the plain snap rings, and they wanted to adopt them, but there was not a machine available to turn them up on. A new vertical boring mill was requested and the request was backed up with all the facts and the advantages to be gained, providing, as conclusively as argument could, the saving in dollars and in increased service from the packing. But all the satisfaction we obtained was, that there was no money available and no matter how great the savings might be we simply could not make the purchase. The same week a new 60-ton wrecking crane was ordered and most of the time it stands on a siding outside of the shop beside several smaller ones, waiting for service or a wreck.

The railroads will not purchase a new outfit of lathes, but continue to use some over 50 years old and are paying men modern wages to watch those antiquated curiosities feebly fooling away their time trying to do the work before them—meanwhile the operator is resigned to slow death. These same roads do not hesitate to scrap locomotives of 20 years ago and purchase modern ones, calling it good business. This may be so, but why not replace mechanical equipment in the shop that is removed more than twice as far from present day practice? It must also follow that this is just as profitable as the reasoning applied to the scrapping of the locomotives. This critical review can be carried back, in many instances, to show the neglect of railway officers in not keeping up their shops. It is certainly poor reasoning to spend ten dollars for labor when one dollar in tool service and four dollars in labor properly supported could have saved five dollars on the same job, and when this support would restore the interest of the men in their work.

I contend that railroad officials do not properly appreciate or support the repair plants.

Too Much Petty Jealousy

The railroad organizations are so cumbersome that the process of reaching the final authority is worse than climbing the Swiss mountains, and just about as likely to reach the desired end if the attempt is made single-handed by any ordinary workman. Subordinate officials or workmen dare not address a "higher up" directly or off comes his head.

There is too much petty official jealousy in the average railroad make-up. The authority is too far removed to be efficient. Everybody must see his superior and get official authority before he can act and the different departments and divisions do not co-operate properly to make railroad work attractive or efficient.

What we need is greater freedom among local officials. Lift the red tape and restraint from these officials in small matters. Give each man his work with a man's freedom and place responsibility with him for the results. Then support him with proper and necessary equipment and we will at once begin to get a lot of officials that will take on normal development, exercise their own judgment and increase their interest in their work. A change will then take place in the financial showing of all departments. What railroad men require is a greater understanding as to just what the railway officers really want or expect from them, the custom now being to keep away and show absolutely no interest in the shop except for an official visit preceded by due warning that they will come, about 10 days ahead of the time set. The poor local foremen get busy and wash the windows, whitewash the front fence, clean the waste papers from the fence corners about the place and issue instructions to "close off all air pipes in departments *A* and *B* next Monday morning until after official So and So has left, for we do not want him to

hear the escaping air (dollars) whistling from some 25 or more air hoist control valves and leaky air pipe lines."

Robbing Peter to Pay Paul

For further illustration, what would you think of management that will defer consideration of making an outlay of $500 for the purpose of digging up a sewer tile, draining 21 engine pits on the erecting floor where 200 men are engaged every day, and where it is safe to say 10 per cent of the total efficiency is destroyed because of water in the pits?—On this same erecting floor there is but one crane and men wait a whole day to lift a set of superheater units in or out, or the boilermakers stand around four or five hours waiting to transport a set of boiler tubes, etc.—Where another department will come in and rip up the floor under six or eight lathes a week before the new floor lumber is at hand? Where the purchasing agent is 100 miles away from the shop, never makes a visit or gains any first-hand information and permits an engine to remain out of service for want of parts that should always be in stock? I know for a fact of a case where a man in need of an airpump gasket stripped eight different pumps and then had to use one that he felt sure would not last a week, and remarked that the pump will be back soon though it should remain in service for a year. The enginehouse men will not attempt to fix it, but will rip it off and cry for another, and more than this, suppose air brakes fail and a wreck results, the engineman is to blame. Now, who ever heard of a purchasing agent being to blame? How utterly impossible for a purchasing agent to cause a railroad wreck. The nearest that we could possibly connect them would be in providing inferior material or forcing the continuance in service of material which is not safe, because there is no other on hand to be used. Railroads lose thousands of dollars in not keeping stocked up with necessary materials. A cent saved by being withheld from normal requirement in material is a dollar lost in time in too many cases. Suppose a man wants a ½-in. nut and spends an hour sorting over scrap to get one that fails and ties up a train for an hour. Or if he wants a ¾-in. pipe union, the piper strips a pipe off another locomotive and in doing it loses a piece of pipe three feet long, causing a loss of one and one-half hours time spent by the piper and his helper in looking for it and finally making a new pipe and robbing the second locomotive to get this same union back.

In these cases there are several things that an enginehouse foreman may do. He may lay the engine up and keep her out of service, or he may rob from another locomotive. This is practiced altogether too much, for it costs money to transfer parts from one locomotive to another, and it is not a cure for you always have one locomotive left without parts no matter how many changes you make. The expense keeps mounting until a new part finally arrives. By that time the changing around has met with a question of sizes and the part fits on in its original place. Meanwhile the changes have caused the breakage of a second part, which, if the other part had been left on in its original place, would have continued for years. Locomotives are not maintained to a standard close enough for indiscriminate changing of parts without costly breakdowns. A third plan is to send her back into service, if possible, hoping that she will make the other end of the road and there let "George" worry about it.

An enginehouse foreman makes a request for an item of material; the storekeeper looks it over. Suppose it is for eight driving box shoes for a Consolidation locomotive. The storekeeper has instructions to trim this month, so he follows instructions and orders six shoes; the purchasing agent recalls his trimming policy and off go two more. The order is placed for four. Why is it that when they are delivered to the enginehouse foreman he cannot say "Thank you, just as ordered," instead of losing interest and returning the locomotive to service with defective shoes and 40 points of defective personal feelings? He sees and knows that results like this are official failures, and that he is absolutely unable to help himself. Inefficiency in the official organization causes discord, loss of interest and expense among the workmen.

Organized Labor Dominates the Situation

As before mentioned, workers were formerly handled as a local problem and each problem had its own solution. Today conditions are different and we must consider our entire railroad system as the unit, and worse than this, various branches or trades are interlocked to bring joint pressure, if necessary, to force their demands, and railroads, under federal control, have never been courageous enough to refuse a real demand thus far.

Organized labor has the railroads by the throat and is, at this time, the cause of heavy losses through open and defiant inefficiency. For example, one shop that I know of used to have two men strip the front end of a boiler complete ready for the boilermakers, and they did it in quick time. Today that same shop has to have an electrician disconnect the headlight wires, a machinist removes the marker brackets and lamps, the boilermakers the front end door plate, spark screen and draft pipes, the machinists take out the exhaust tip and base, the boiler makers the draft plates and the machinists the superheater units and damper mechanism. The hold-up is apparent.

Now, why this organization and its inefficient agreement? Simply the limitations of human endurance. The men could not gain anything until they organized and forced it, but even after recent experiences these same officials will no more recognize a workman who loyally stood by his post and their interests by refusing to go out on a strike, than they do the worst agitator who caused the strike.

Labor organizations are all right if properly handled. We know the parent organization as the American Federation of Labor. Certainly a fine name, and we would expect American standards of patriotism to find expression among their activities. But here is where it seems to fail. I would insist first of all that none but American citizens could hold office within its ranks and all alien members should lose their voting power. No leader or agitator should be allowed to address their meetings or distribute circular matter written by any alien If I had my way, citizenship would be necessary to gain admission to the membership and all those that are members at the present time would have to become American citizens or get out of the union. Any member engaged in disloyal activity would be expelled. In short, I would make the Federation of Labor an asset to our nation and not the propagating ground for anarchy.

How to Improve Conditions

How can we improve conditions? How can we make the railroads change about and earn not only their operating expenses, but pay a rental for the money already invested as well as to create a condition where real live workmen will take part in the work, and an investor will hazard his money in their care?

The answer is, we must study human nature, and hav real live men take part in railroad administration and operation. This is evident when you look at the long line of failures that follow almost every railroad man when he leaves railroad work and tries his hand at other lines. He doesn't last long enough to make it worth mentioning. Why? Because in railroad work he was never placed where he carried any real responsibility. The "higher ups" prescribed his work so completely that he never had a chance to know what personal initiative meant as connected with him. No, he never knew what it meant to shoulder a situation and go

through with it himself, and so it goes, once a railroad man, always a railroad man, unless the "get-away" was quick and he did not fully get into the rut.

What I would like to see is the higher officials to drop their distant, aristocratic, important, special car stuff and get back to first principles, be real men again, and in good democratic fashion have, at least once a year, a banquet, picnic, or get together under any pretence, where every worker could have a chance to see and talk with his officials and listen to a real declaration of purposes and principles. Not the present code that has seeped through the blockade of unwilling chief clerks and department heads. To do this in a free manner implies, of course, that the president or ranking official is all that the job calls for, the real thing and not somebody's son or cousin, who serves as a figurehead. The time is here when we must make our railroads democratic, we must have real live one hundred per cent Americans nd practical men who have the capacity for their official tasks. The favored son or relative day is past. Officials must meet, study and understand their men and their needs. They have got to surround their subordinates with an atmosphere of hope, fair dealing and encouragment, which will create conditions for departmental co-operation. There is a world of power in the brains of the workers if their officials will permit it to come to the surface and use it.

Increased Pay Alone Not Sufficient

I am a strong believer in humanity when given encouragement and understanding, and know that increased pay or wages will never satisfy or stabilize workers anywhere. There is not a case in all history where money alone permanently satisfied human nature. It may produce conditions leading to abundant happiness, but of itself alone it only proves in the long run slow poison to manhood and individual advancement.

Robinson Crusoe threw it away. Shylock retained it and threw himself away. William Penn used it and was happy in the service that it made possible for him to render humanity. Labor organizations have constantly asked for more pay and shorter hours, better working conditions and the establishment of restrictions that have reduced the production per unit time at least 50 per cent. The encouragement given to these organizations during past two years has produced a ridiculous disrespect among the members for the very people who must pay the price for all the advantages, as well as those who granted the concessions.

Co-operation and Loyal Service

We are confronted by two problems. Inefficiency and disloyalty, and the charge is up to both officials and men equally. The relations between officials and men are just reversed. The officials seek to forsake and neglect and men try to produce as little as possible. With this condition on our hands how are we to arrive at a solution that will effectually line up all hands for loyal, full 100 per cent cooperation and service?

It must start with the officials, they must have money to purchase shops and equipment, and the men must be brought into a new spirit of appreciation of the importance of full cooperation and respond with loyal service. They can do this by proper mental discipline, forsaking outside discordant leadership, engage so fully in their work that it returns satisfaction from the consciousness of having done well, whatever the task that may be theirs. Make the shop atmosphere an asset so forceful and progressive that the officials will find more pleasure in frequent visits. They will realize that it is better business to keep their individual employees straight by personal contact, than it is to read, in the seclusion of their private office, a cold report of how many bent spikes were straightened at the scrap yard. The salvaging of scrap material is good business, but the keeping of our human factor above scrap valuations is a better official pastime and when that is realized, there will be, due to a higher degree of interest within the workmen, thousands of dollars worth of material used, that is at the present time dropped into the scrap.

But how are we to break the ice and change relations? Official abandonment has forced organization upon the employees. No better means is at hand to work out this problem than through organization. Organize how? Who? Organize all the employees of a road into one complete family of interest as loyal as a hive of bees, and let the employees have a voice in the management. When the officials need money, issue bonds of low denominations and sell them to their employees. There is all the money they need right at home—why not use this asset which has always been available, and is now. Do not cry poverty, higher transportation charges, etc. Cast off that Rip Van Winkle stuff, and let us see ourselves as others see us. When you accept an employee's money into a business that he is selling service to and has a voting power in, you get his good will, and this is worth more in actual cash to our railroads today than all the money that they measure on the deficit side of their ledgers.

I believe in myself, I believe in the future of our roads, either under private or government ownership, and I believe in our state and nation. But I am not satisfied with present day conditions or relations. I do not believe a body of Congressmen, absolutely ignorant of railroad affairs, can ever furnish the relief we need at this time to place the railroads on their feet. To further illustrate, take any business proposition and put it up to the politicians to solve. I do not think there is one man in Congress out of three and perhaps out of ten who can handle bookkeeping or can audit an account, and how can they pass reasonably on a business proposition, let alone one like the railroads. The solution is not there. Where is it? Among the railroad employees themselves. There is not a man working for any railroad in the United States, in any capacity, but has an honest criticism, and also a remedy. The collection of such material and molding it into a new plan of management will go a long way towards improving conditions all along the line, clear up to a cash balance on the proper side of our books at the close of business each month. Labor will become smoothed out and the railroads will cease to be a national danger and worry. They will furnish the service that will efficiently handle the business of the best country and nation on earth. A fair portion of this profit must come back to the man in "jeans" that has faithfully and steadfastly performed his task, no matter what it may be.

My faith in humanity is my faith in America and the solution of this problem.

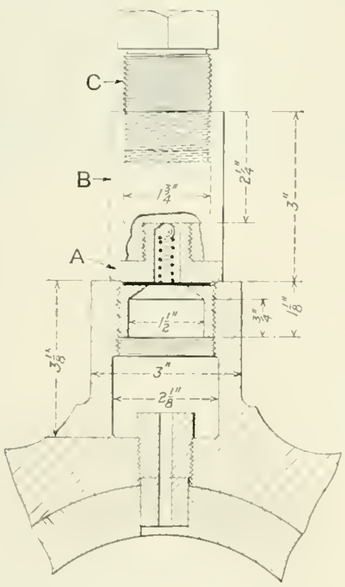
One of the Two Bays of the Erecting Shop of the A. E. F. Engineers at Nevers, France. American Locomotives on the Left and Centre Tracks. French Locomotives on the Right Hand Track.

A PLUGLESS GREASE CUP

BY J. P. RISQUE

Owing to the loss of 300 grease cup plugs and lock nuts from locomotive side rods, the mechanical department of the Florida East Coast Railroad has produced a design which has been tried on three locomotives for some time and promises to eliminate the losses referred to.

The attachment, as illustrated in the drawing, is intended to be used on cups which are forged as integral parts of the rod. The outside threaded cap *A* is turned from a solid bar of soft steel and is made to screw into the rod cup very tightly. It is provided with a cup approximately ¾ in. deep by 1½ in. in diameter to contain the grease. The base of the coil spring, shown in section, is seated on a steel pin which is driven through from the side of the cup in the position indicated. The expansion of this spring seats the ball against the top filling hole, closing it.



Plugless Grease Cup with the Filling Apparatus Attached

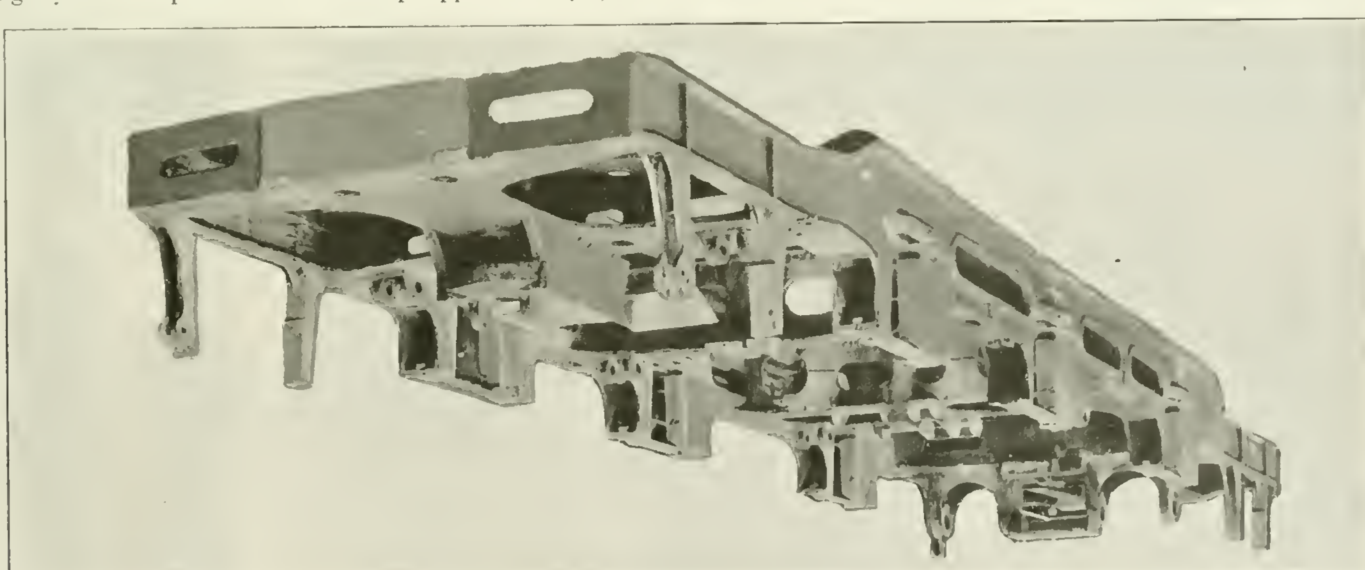
The filling apparatus consists of a special shell *B* and its force plug *C*, the former being screwed on the projection of the cup. The shell *B* is filled with a section of grease cut to the necessary size to prevent waste and the plug inserted and screwed down, forcing the grease through the filler hole against the ball and down into the cup. When the cup is filled the filling shell and its plug are removed.

The favorable reports on the performance of this cup warrant its adoption as standard by the Florida East Coast. The reports show that the first cost of the device is more than offset by the savings it has brought about, not only by eliminating the loss of plugs, but by a considerable reduction of side rod brass losses due to running hot.

ONE-PIECE CAST STEEL FRAMES FOR ELECTRIC LOCOMOTIVES

A notable example of the large and intricate parts which are successfully made of cast steel is the bed casting for the latest order of electrical locomotives built for the New York, New Haven & Hartford, illustrated herewith. In designing this locomotive the weight of the built-up frame was found to be so great that the total weight would exceed the allowable limit. For that reason the Commonwealth Steel Company, St. Louis, Mo., was asked to submit a design. The general plan for such a casting had been worked out by the company's engineering department, but the 10 beds for the New Haven locomotives were the first to be made.

The locomotive bed is 32 ft. 4 in. long, weighs 17,000 lb. and is probably the most difficult casting of its kind ever attempted. This single unit replaces a very large number of parts, greatly reducing the weight and increasing the strength. Numerous bolts and nuts have been eliminated that become loose and allow play, especially at the pedestals. This will result in a considerable saving in the cost of maintenance and repairs. This locomotive bed strikingly illustrates the adaptability of cast steel to certain types of construction. It not only provides an irregular contour of members for clearance without sacrificing strength, but also facilitates securing various cross sections of all members, correctly proportioned in size to correspond with various stresses, at the same time providing the required flexibility in the structure.



Cast Steel Bed for New Haven Electric Locomotives

During the months of January and February the Railway Age reported orders for 364 locomotives, 8,616 freight cars and 60 passenger cars for domestic service. There were also ordered 268 locomotives and 1,560 freight cars for export. In the week ending February 27, 207 locomotives were ordered for domestic service.

PRAIRIE TYPE LOCOMOTIVES FOR THE KIN-HAN

The Lima Locomotive Works has recently built for the Kin-Han Railway of China ten 2-6-2 type locomotives to be used in mixed service. This road runs from Pekin to Hankow and because of track conditions a number of difficult engineering problems had to be met in the design of these locomotives. There were very close limitations of weight for both the engine and tender. There were also rigid requirements in connection with the counterbalancing of the reciprocating parts and the locomotives were required to pass over 22-deg. curves. To meet these conditions and produce a satisfactory design of locomotive required great care in designing and construction. The engines have been built and fully meet the requirements in all particulars.

The limitations of weights made it necessary to design all the parts as light as possible, consistent with the proper strength. The built-up type of construction of plates and angles was freely used in the main frames and the tender frame bracing wherever it was found that such a construction could be satisfactorily employed. Care was taken to produce a symmetrical, clean looking design and wherever it was feasible the parts were made in one piece. For example, the guide yoke and the link supports were made in an integral casting, thus eliminating bolted connections and reducing the weight of the parts.

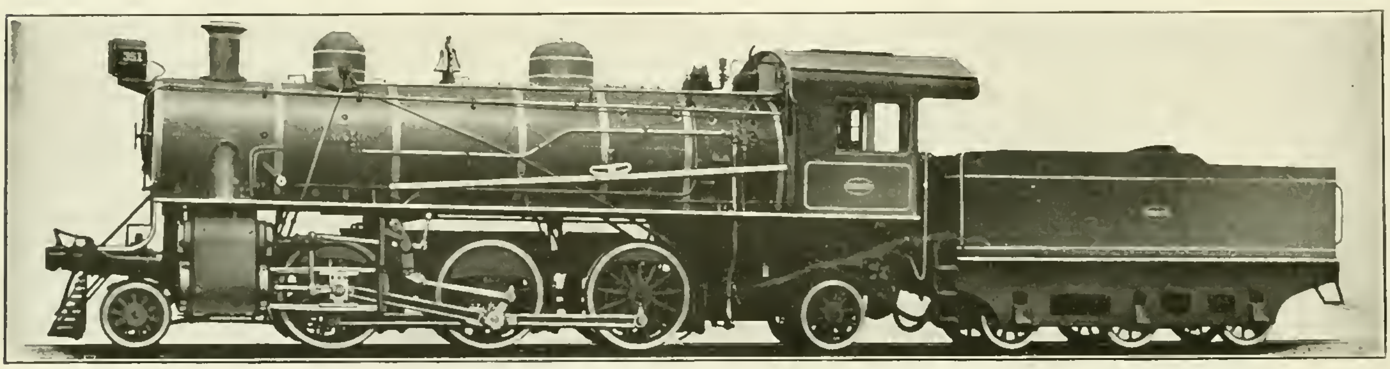
The limit for the dynamic augment at a speed of 50 klm. (37.3 miles) per hour was specified at 15 per cent of the coal capacity of 13,300 lb. The water capacity of the tender is 4,800 U. S. gallons.

Great care was necessary in making the tender design to meet the limitations of axle load as given in the specification. In general, the locomotive was designed along the lines of American practice and the builders were given a free hand in the construction of details so long as they were kept within the limitations of the specifications. The general dimensions of the locomotive, as well as the actual weights as compared with the weight limitations specified are given in the following table:

	Actual weight	Limit of weight
Engine		
Front drivers	32,600	33,000
Main drivers	32,600	33,000
Back drivers	32,000	33,000
Total drivers	97,200	99,000
Engine truck	28,400	28,500
Trailing truck	30,400	31,300
Engine, total	156,000	158,800
Tender		
Front wheel	30,400	30,800
Middle wheel	30,600	30,800
Back wheel	30,600	30,800
Total	91,600	92,400

General Data

Gage	4 ft. 8½ in.
Service	Mixed
Fuel	Soft coal



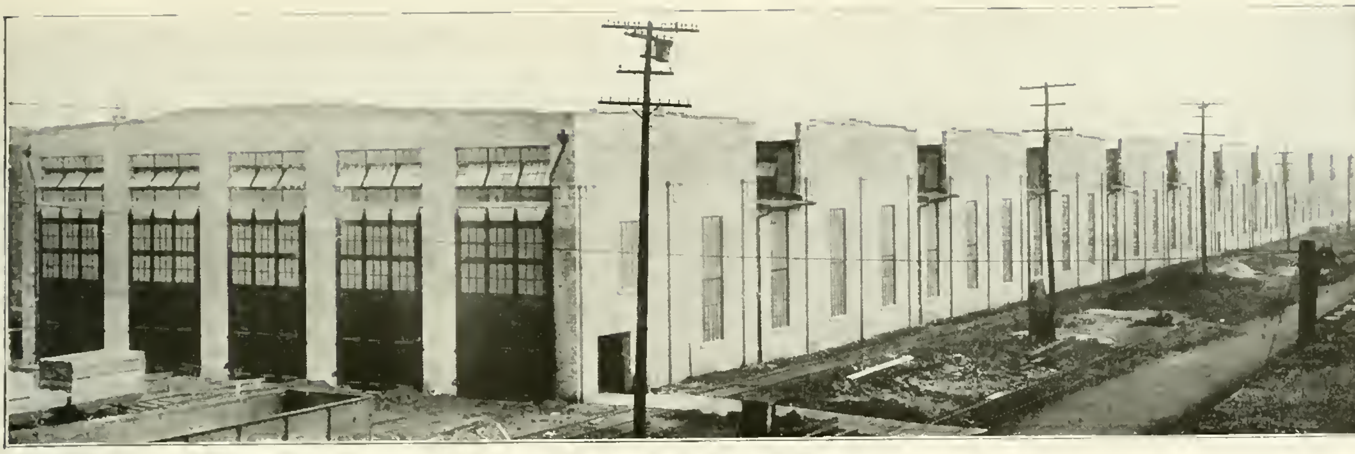
Prairie Type Locomotive for Service in China

static wheel load. In order to come within these requirements and at the same time provide the proper counterbalance, the reciprocating parts were made of very light design and a special method was employed to secure an exact adjustment of the counterweights in the driving wheels. The dynamic augment requirements were met and by means of careful adjustment the proper counterbalance was secured for the reciprocating weights.

The boiler is of the extended wagon top type, radially stayed and fitted with a combustion chamber. The locomotives are equipped with superheaters and the reversing mechanism is of the Lawson patented screw type, which provides for easy operation and is fitted with a positive locking device and an indicator which shows the exact cut-off at which the engine is operated.

The tender is of the six-wheel, rigid wheel base type, with plate side frames, the journal boxes working in pedestals riveted to the outside plates of the frame. The two rear pairs of wheels under the tender are equalized. The tender tank is 20 ft. 8 in. long by 9 ft. 8 in. wide by 4 ft. 2 in. high inside, and is built up of ¼-in. steel plate reinforced with 2½-in. by 2½-in. by 5/16-in. angles. The coal space is 4 ft. 9 in. wide and is 6 ft. 2 in. long at the floor, extending back on the slope sheet for a distance of 5 ft., giving a

Tractive effort	25,500 lb.
Weight in working order	156,000 lb.
Weight on drivers	97,200 lb.
Weight of engine and tender	247,600 lb.
Wheel base, driving	13 ft. 10 in.
Wheel base, total engine	31 ft. 7 in.
Wheel base, total engine and tender	53 ft. 10 in.
Cylinders, diameter and stroke	20 in. by 26 in.
Valves	12 in. piston
Drivers, diameter over tires	59 in.
Driving journals, diameter and length	8½ in. by 11 in.
Boiler	Extended wagon top
Working pressure	170 lbs.
Outside diameter, first ring	61 1/16 in.
Firebox length and width	84 in. by 54½ in.
Tubes, number and diameter	130, 2 in.
Flues number and diameter	21, 5⅜ in.
Heating surface, tubes and flues	1,418 sq. ft.
Heating surface firebox including arch tubes	207 sq. ft.
Heating surface total	1,625 sq. ft.
Superheating surface	366 eq. ft.
Grate area	31.6 sq. ft.
Tender	
Type	Six wheel
Tank	U shape
Frame	Plate
Weight	91,600 lb.
Journals, diameter and length	5⅛ in. by 10¼ in.
Water capacity	4,800 U. S. gals.
Coal capacity	13,300 lbs.



A Longitudinal Type of Repair Shop.

Modernizing Freight Car Repair Facilities*

A Presentation of the Several Phases of This Subject and a Proposed Shop and Yard Layout

BY GUSTAVE E. LEMMERICH
Layout Engineer, The Austin Company, Cleveland, Ohio

The tremendous industrial growth of our country, its railroad traffic and its foreign commerce has created a need for a transportation machine which will not only meet these demands but also keep abreast of the times. It has been estimated that there is an urgent need for 700,000 new freight cars; but even if this is true, it will be practically impossible to obtain delivery of such a large number for several years, as there is at the present time an insufficient manufacturing capacity. The total existing freight car equipment consists roughly of about 2,500,000 cars. If facilities are provided for obtaining the maximum road service from these cars, quicker relief will be afforded perhaps than could be secured by waiting for the delivery of all the new cars needed. For instance, statistics recently compiled by competent operating officers show that the average car-miles per day on several important roads have varied from 25 to 37. Any improvements which will bring the low average nearer the high average of car-miles per day will produce more net revenue than the purchase of new cars. Undoubtedly, a combination of the two means of relief will be necessary to bring about the desired results.

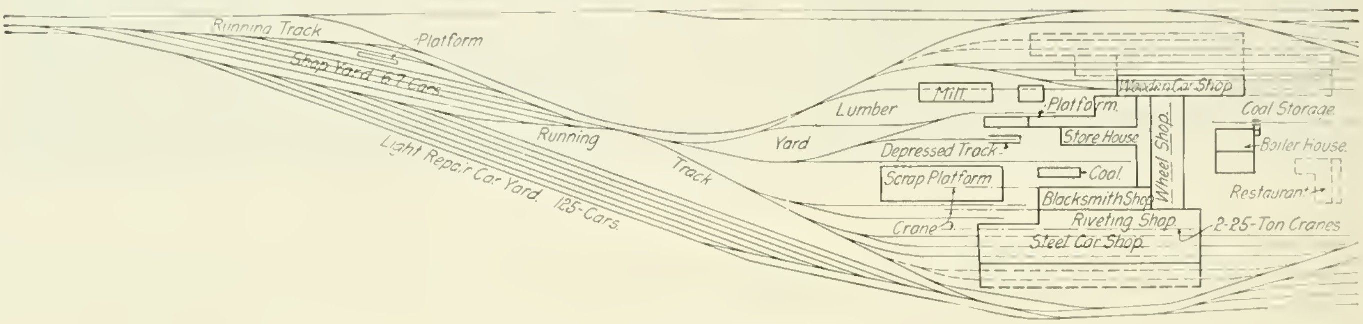
In 1917 about twenty-nine million cars received light repairs and about two million cars received heavy repairs, i. e., practically every car was sent in for light repairs once a month, and about 80 per cent of the total equipment underwent heavy repairs once a year. For the past four years the average cost of these repairs has more than doubled. The weighted average cost of freight car repairs, computed from an article on "The Maintenance of Freight Equipment" by L. K. Sillcox, on page 657 of the November, 1919, issue of the *Railway Mechanical Engineer,* was about $79 per car in 1916 and $170 in 1918. These costs were based on about 500,000 cars. This increase was due in general to the high cost of materials and labor, the construction and condition of the cars, and the lack of proper facilities for making efficient repairs. It does not appear that the first item will change much for some time, but it is probable that labor costs will

A Paint Shop of the Transverse Type

decrease, due largely to increased efficiency. This combination of high costs and ever-increasing traffic calls for prompt improvements in handling all car repairs, and particularly affording a means of making light repairs independent of weather conditions.

Making Needed Improvements

There is an apparent tendency toward better and stronger rolling stock, designed to withstand the heavy strains of long



Main Group of Repair Shop Buildings

train and yard operation. Old, weak equipment should be reinforced or assigned to a class of service in which it may still be useful, or it should be scrapped. All underframes in heavy freight service should be of steel.

It does not appear that the seriousness of the car situation lies so very much in the present needs for a large number of new cars as in the immediate demand for proper

Interior View of the Transverse Shop

facilities for repairing and modernizing the present equipment, and for the pushing of other improvements which will tend to better car movements at the terminals and on the line. Inasmuch as those facilities are so closely interwoven with the freight car situation, an outline of some of the important suggestions, which will tend to improve the car situation, may not be amiss:

Car Equipment.

(a) Modernizing old equipment. (b) Larger and stronger cars.

Car Repair Facilities.

(a) Better and more conveniently arranged shops, equipped with facilities for accelerating the return of the equipment to revenue service.

Traffic Improvements.

(1) *General.*

The continuation of the Railroad Administration Car Service Section, revised to suit the new conditions.

(2) *Reduce Time at Terminals.*

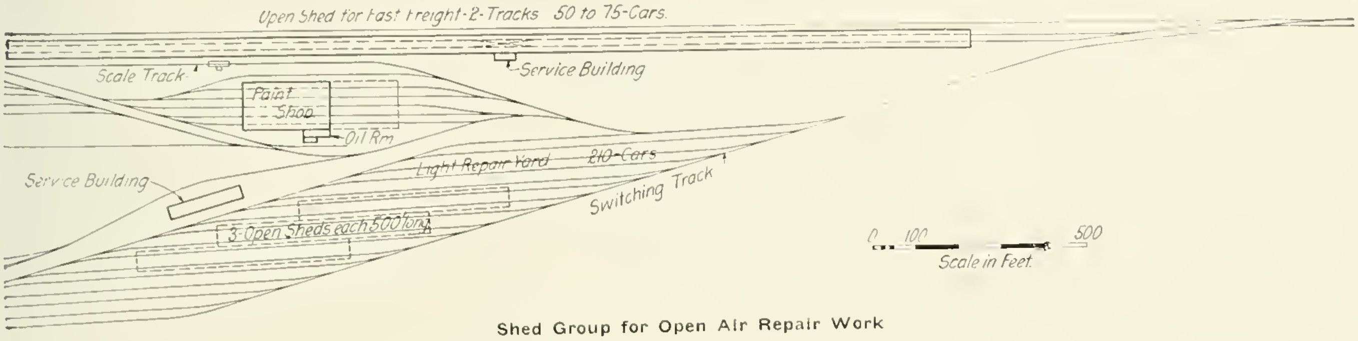
(a) The continuation of the present policy of unification of terminals. (b) The establishment of union freight stations in the larger cities. (c) A more universal application of modern loading and unloading devices. (d) Improvements of terminals, varying from some minor betterments costing only a few thousand dollars, to vast projects, such as detour lines around the great congested traffic centers.

(3) *On Line.*

Other improvements, such as additional tracks, automatic block signaling, etc.

(b) Important changes resulting from the consolidation of railroads, creating new steam traffic lines.

All of these improvements would greatly facilitate car movements, and they would result in returning cars much quicker, so as to increase their earning capacity. For example, if these additional betterments would result in only a 10 per cent earlier return, it would mean at least a reduction of about 8 per cent in the number of cars needed to relieve the present shortage.



Shed Group for Open Air Repair Work

A tentative estimate of the new freight cars required in the next three years calls for about 700,000, or about 230,000 cars per year. Eight per cent of the yearly requirements would be about 18,000 cars. At an average cost of $2,850 per car, this is equivalent to a total cost of $51,300,000. Capitalizing this sum at 10 per cent for interest, depreciation, etc., will provide a fund of $513,000,000 available for these improvements. This sum would go a long way toward paying for most of the improvements suggested.

Interior of the Longitudinal Type Shop

General Freight Car Repair Shop Requirements

The question of the location of car repair shops is chiefly dependent on the dominating traffic characteristics and on the prevailing local conditions of the particular railroad considered, its size, the empty car movements, the available and suitable site, the labor conditions and the material market, etc. In former years, when the mills and the lumber yards were of greater importance in freight car repairing, the main car shops were, in many instances, located at the general repair shop plant of the system, only a few railroads selecting separate locations. The freight car repair shop organization is so different in its character and functions that there is no advantage in having it at the general repair site, except that both should possess all the particularly favorable points affecting construction and operation.

On the larger railroads the traffic conditions are often so greatly divergent in character that, in order to save empty car mileage and to return the cars quicker to their earning power, it might be advantageous to divide the car repairing between district shops. This division could be extended to provide separate repair shops for steel cars and for wooden cars, each located at the most suitable place.

The layout should embody the principle of a continuous mill operation, the materials entering as much as possible at one end, and the building and organizations so grouped as to avoid any conflicting movements. Such an arrangement is indicated in the tentative layout accompanying this

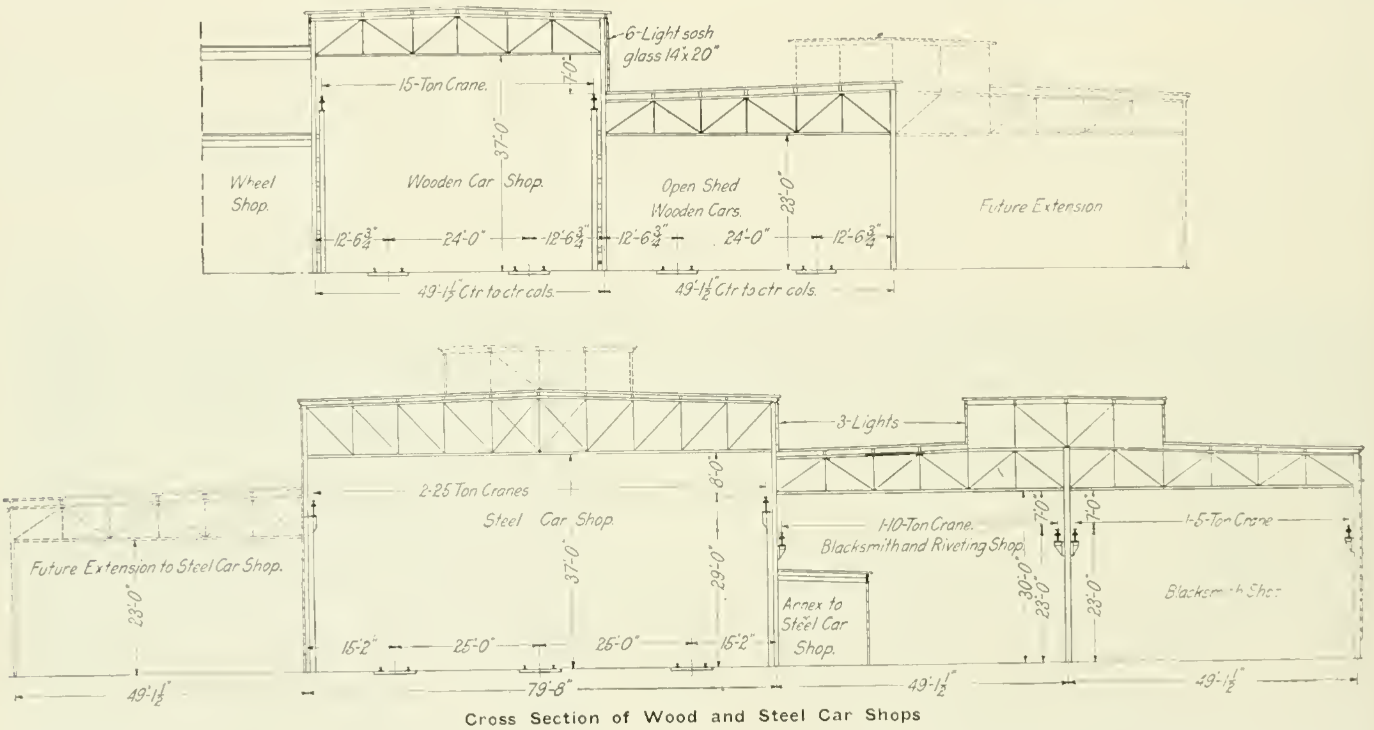
article. The principal buildings should be all under one roof, effecting a saving of a large amount of unnecessary travel and adding greatly to the efficiency of operation.

All buildings should be commensurate to the purpose they have to serve, i. e., they should be of a substantial character, void of all fads, but equipped with all modern facilities. Inasmuch as these structures require large areas, standard dimensions should be adopted wherever possible to reduce the cost and to shorten the time of construction. Such standards should cover the width of the buildings, the vertical clearances, and the column spacing, etc., due consideration being given to the local and operating requirements. The track centers should be such as to give a good workable aisle width, a feature which is of special importance in steel car shops on account of the space needed for the riveting furnaces. This applies to the tracks besides the building walls, as well as to the interior aisles. The buildings should be well lighted, heated and ventilated, and should be provided with cranes wherever they will result in better and more efficient operation.

In former years the wood mill was one of the pivotal features in the layout, but now that wooden underframes are practically a thing of the past, so far as new work is concerned, this department has lost its importance, and a comparatively small building with a few tools is all that is required. The mill, however, should have as an auxiliary a finished lumber shed. The lumber yard has also shrunk to comparatively small proportions.

Auxiliary Building and Equipment

The storehouse with its platforms should be located centrally and conveniently. The building should be of reinforced concrete, provided with a full equipment of bins, an office, etc. The scrap platform in a freight car repair plant is of great importance and should be readily accessible for the delivery of scrap and for the forwarding of it to the blacksmith shop. This platform should also have facilities for the handling, cutting, sorting and storing of all grades of scrap, and a shed for housing some of these should be provided. The other auxiliaries to the storehouse should



Cross Section of Wood and Steel Car Shops

In general, car repair shops are located in or near large freight yards and, in most cases, on filled ground. These conditions, together with the fact that car repair plants are frequently built outside of cities, render it advisable to make the buildings of steel frame construction with walls practically entirely of glass. Where the application of glass is not desirable, such as at the corners and below the windows, asbestos-covered corrugated metal or some other permanent wall substitute should be used. The use of brick should be limited as much as possible or eliminated entirely in order to simplify the construction. The roof can be built with wooden purlins and 2-in. dressed and matched roof boards, the under side being whitewashed to serve as a fire retardant.

A dirt floor appears to be all that is needed in the buildings used for the steel car departments; this can also be used for the wooden car shops in order to reduce the initial cost. If, later, it should be found desirable to have a floor in the wood car shop, old car sills can be used advantageously. In the mill, the wheel shop, and the tool room, the use of creosoted wood blocks laid on a concrete base will be found to be satisfactory, while concrete floors are most frequently used in the storehouse, locker and toilet rooms.

include storage places for wheels, steel plates, angles, beams, castings, etc., and coal, coke and iron sheds for the blacksmith shop. The ground for these storages should be, above all, dry and well rammed with slag.

If this plant is isolated, it will require a fully-equipped power house. If, however, the plant is attached to or near an engine terminal or some other shop layout, the need for a power house is entirely dependent on the respective local conditions. A very important piece of equipment, usually installed in the power house, is the air compressor, which is generally of too low a capacity to meet the present increasing demands. The main shop buildings should have provisions for offices, lockers, wash rooms, toilets, etc., and other plant requirements, such as drainage and sewer system, a water supply and fire protection system, a lighting system, an air piping system, telephone and telegraph connections, if desirable, and finally the necessary yard tracks, etc.

Equipment and Tools

The shop should be fully equipped with modern tools and machines to do the work for which the plant is intended. The power equipment should be on liberal lines, especially

the air compressors. In specifying them, it should be considered that some light repairing may have to be done outside of the regular working hours.

Crane service should be provided wherever it will be economical, and the use of cranes should be extended outside of the building in order to facilitate the handling of material from the yard and to serve in repairing cars during that period of the year when the work can be done on the outside. Such an application will decrease the amount of the fixed charges per car repaired, resulting from the cost of the complete shop plant. The cranes in the steel car shop should have a capacity of 25 tons. In any important layout two should be installed which, when working together, can manage a 150-ton capacity car. In the wooden car department, cranes of 15 tons' capacity will be sufficient. The installation of cranes in the auxiliary departments depends, of course, entirely on their importance. A large locomotive crane is generally a good paying investment, because it combines the handling of material and the switching of cars in one unit. Of late a powerful tractor has been found to be a useful piece of equipment for transporting all classes of material about railroad shops and yards.

This article is confined to a repair shop with some rebuilding, so that the repairing functions, being in preponderance, govern the character of the layout, organization and equipment. The great importance to some roads of having most of its car equipment provided with steel underframes might make it advisable to enlarge the repair shop riveting department, so that some or all of the new steel underframe work of the system could be undertaken. Such an arrangement might stabilize the work and organization of this shop, and will only require a somewhat longer building and few additional tools. Local conditions might make it desirable to have a restaurant, reading rooms, etc., connected with this plant. These could be located in a service building back of the power house. Part of the ground surrounding this building could be treated in some pleasing way for recreation, etc.

A plant serving a district was selected for the tentative layout because shops of this type are particularly suited to meet the present needs; moreover, they conform better to economical freight car operation because their location would result in a minimum empty car movement, yet they are large enough for economical operation.

The Tentative Layout

The plan represents a repair shop with a capacity of about 9,000 cars per year, and provides separate shops for wooden and steel cars, connected by a wheel shop with a crane that will transfer the material between the two shops. It is assumed that this plant is located in a terminal, with its entrance, the yards for the shop and the light repair work directly behind the criple tracks near the hump on the main traffic yard, or beside one which would be a starting point for the majority of empty car movements.

Of course, this layout must be arranged to conform with the existing local or other traffic conditions, but it must still retain certain vital principles. These include a departmental plan of the yard and buildings, so that the movements of the material are such that the entire plant is on the continuous mill principle, and an interchangeability of the two yards for both the shop and the light repair yard. The buildings for fabricating the materials used in car repairs, such as the mill with its lumber shed, the blacksmith shop, the storehouse, etc., are entered first in the operating plan. With the exception of the mill, the power house and the paint shop, all buildings are under one roof, and this, taken in connection with the crane service, as outlined later, should greatly facilitate the car repairing.

The wooden car shop proper is 50 ft. wide by 300 ft. long, with a capacity of 32 cars, assuming 50 ft. as the length required per car when undergoing repairs, and contains two tracks and one 15-ton crane. The crane runway extends outside of the building, bringing 8 cars under crane service. Adjoining this shop is a covered shed holding 12 cars. The steel car shop is 80 ft. by 520 ft. in area, and contains three tracks, holding a total of 27 cars, which are served by two 25-ton cranes. One track is cut to permit the placing of a large furnace and some tools in the bay, so formed in order that the crane can carry large sections of damaged steel to the furnace, to the tools and back to the car proper.

In the car shops the distance from the top of the rails to the under side of the trusses is fixed at 37 ft., and to the top of the crane rail 29 ft. and 30 ft., respectively, for the steel car shop and the wooden car shop. This height will permit the handling of side plates, etc., of steel cars of considerably higher and greater capacity than are now in use.

The blacksmith shop is located in two aisles, one adjoining the steel car shop at the furnace section, so as to bring it into the blacksmith shop organization. The riveting shop adjoins the steel car shop, but is at the finished car end of the building; its width also being 50 ft., with its length dependent on the amount of new steel underframe work assigned to it. Both of these auxiliary shops are equipped with cranes. The wheel shop proper is 50 ft. wide by 260 ft. long, with two side aisles, each 30 ft. wide, one containing the tool room, which is back of the storeroom and directly connected to it; the offices and some minor machine tools, etc., while the other aisle contains the fan rooms, lockers, wash rooms and toilets.

The paint shop is situated beyond the other shop buildings and is a well-lighted building, with posts between each track, with dirt floors, and with pits under two of the tracks. The size of this building is assumed to be about 100 ft. wide by 200 ft. long, with a fireproof oil storage room in the form of an addition to it. In case it should be preferred to paint some parts or all of the steel cars in the steel car shop, the paint shop could be greatly reduced or omitted entirely for the time being.

At the farthest end of this layout there are a few yard tracks to accommodate the cars from the other hump.

An approximate estimate of the cost of the freight car repair shop, as indicated in this layout, is as follows:

	Cost		Per cent of total	
Grading and Track				
Grading and drainage	$44,000		3.5	
Track	91,000		7.5	
Total		$135,000		11.0
Buildings				
Wood car shop, covered shed and crane run way	$65,000		5.5	
Mill and finished lumber shed	24,000		2.0	
Wheel shop, tool room, etc	68,000		6.0	
Steel car shop, blacksmith and riveting shops, crane runways	220,000		18.5	
Storehouse platform, scrap platform, etc.	40,000		3.0	
Paint shop	35,000		3.0	
Power house, including coal and ash handling, stack, etc	72,000		6.0	
Miscellaneous—Water supply, fire protection, sewerage, plumbing, walks, etc	36,000		3.0	
Total		560,000		47.0
Equipment				
Tools	$165,000		14.0	
Power house	115,000		9.5	
Cranes	105,000		8.5	
Total		385,000		32.0
Miscellaneous				
Cost of land, interest during construction, engineering and contingencies		120,000		10.0
Grand total		$1,200,000		100.0

The fixed charges on $1,200,000 at 12 per cent per year would amount to $144,000.

These improvements should result in a reduction in the cost of repairing per car, and in a reduction in the time consumed in having these repairs performed. Assuming a 10 per cent saving in the repair account which, at an average

cost of $170 per car, would amount to $17, or, on 9,000 cars per year, would amount to $153,000, or more than enough to finance the improvements. In addition, the time saved by a plant of this kind in returning cars to their earning power more promptly, also represents a money saving which can be used for financing other improvements.

The Light Repair Yard

There appears to be a tendency in the development of light repair yards to cover a part of the tracks to protect the repairmen against inclement weather. If this is applied along reasonable lines, it will promote more efficient and quicker car repairing, and, at the present rate of wages, will also prove to be a paying investment. If this should run to the extreme, however, it might result in an entirely different type of layout for the light repair yard. Perhaps it might tend to enlarge the sphere of the repair plant and make it necessary to provide a series of open sheds beside the repair shop buildings.

In this layout the light repair yard consists of 14 tracks of 15 cars each, arranged in pairs on 22 ft. and 28 ft. centers, thus permitting an open shed, when so desired, for the storing of material, pipe lines, etc., which could be about 500 ft. long and cover 20 cars each. The material storage shop, a storeroom, an office and the locker, wash and toilet facilities, are located at the ladder track toward the main shops. The switching is done from the ladder on the other side of the yard, so that this ladder is only used in emergencies. The size of these facilities is dependent on their importance and the local conditions prevailing at the terminal. An approximate estimate, which includes three open sheds, each 500 ft. long, theoretically covering 60 but practically 75 cars, is as follows:

		Cost	Per cent of total
Grading and drainage	$40,000		
Track	85,000		
Total		$125,000	53.0
Service building, including plumbing	$15,000		
Equipment, fire protection, etc.	15,000		
Total		30,000	13.0
Three covered sheds, 500 feet long		45,000	19.0
Miscellaneous—Cost of land, interest during construction and contingencies		35,000	15.0
Grand total		$235,000	100.0

Fixed charges on this investment at 12 per cent equals $28,200 on 80,000 cars a year, which is the average number such a yard should handle, and it will result in a cost of about 35 cents per car receiving light repairs. The open shed represents about 19 per cent of the total cost.

An Open Shed for Through Freight

The tentative layout also indicates an arrangement for an open shed for fast through freight trains, which will tend to facilitate inspection, the testing of air and some very light repairing under all weather conditions, thus decreasing the chances for delays at the terminals. However, local conditions might make it advisable to place these sheds at some other point. The layout is for two tracks, each holding 56 cars 42 ft. long. A diamond cross-over at about the middle of this shed permits a single track operation when required, and about two 22-car sections may be set for very light repairing. For this layout the size of the shed was assumed to be about 40 ft. by 2,260 ft., with posts set 22 ft. apart on center. The construction is of wood, and the shed should be provided with air pipes and a small shelter in the center for an office, a few tools and the toilets, etc. An approximate estimate of the cost is as follows:

Open shed and small service building annex	$56,000
Air piping, few tools and diamond cross-over	5,000
Miscellaneous	4,000
Total	$65,000

The fixed charges at 14 per cent per year would amount to $9,100. Assuming this shed will be used by 100,000 cars per year, the fixed charges per car will be 9 cents.

Committee on Standards for Locomotives and Cars, United States Railroad Administration

First Row—Seated (Left to Right): J. J. Tatum, general supervisor of car repairs, U. S. R. A.; F. P. Pfahler, chief mechanical engineer, U. S. R. A.; Frank McManamy, assistant director, division of operation, U. S. R. A.; and chairman of the committee; John Purcell, assistant to federal manager, Atchison, Topeka & Santa Fe; A. W. Gibbs, chief mechanical engineer, Pennsylvania Railroad. Middle Row Standing (Left to Right): C. E. Fuller, superintendent motive power and machinery, Union Pacific; F. F. Gaines, Board of Railroad Wages and Working Conditions, U. S. R. A.; W. H. Wilson, assistant to federal manager, Northern Pacific; H. T. Bentley, superintendent motive power and machinery, Chicago & North Western; J. E. O'Brien, superintendent motive power, Missouri Pacific; J. T. Carroll, general superintendent, maintenance of equipment, Baltimore & Ohio. Top Row—Standing (Left to Right): H. Zalkind, stenographer; J. W. Small, mechanical assistant to regional director, Southern Region, U. S. R. A.; E. A. Woodworth, secretary; H. Ingersoll, mechanical assistant to regional director, Eastern region, U. S. R. A.

The Inspection of Freight Equipment

Defects of Couplers and Related Parts; Federal Requirements for Safety Appliances Summarized

BY L. K. SILLCOX

Master Car Builder, Chicago, Milwaukee and St. Paul

COUPLERS must be in good condition as regards wear and operation of parts, and should be within the minimum and maximum heights as provided by the rules of interchange. Couplers that exceed the distance of 5⅛ in. between the point of the knuckle and the guard arm, measured perpendicularly to the guard arm, must have the defective part or parts renewed to bring the coupler within the limits of the gage.

Couplers measuring less than 9¼ in. from the inside face of the knuckle to the striking face of the coupler horn should not be applied in repairing foreign cars. This should not be construed to mean that a coupler with 9¼ in. dimensions may be substituted for the MCB temporary standard type *D* or 6 in. by 8 in. shank coupler. It is necessary to stencil cars equipped with the *D* type of coupler in order to protect them against substitution of the present type with 5 in. by 7 in. shank.

Height of Couplers

Empty cars measuring 32½ in. or less from the top of the rail to the center of the coupler shall be adjusted to 34½ in. or as near as practicable thereto, but not exceeding 34½ in. Loaded cars measuring 31½ in. or less shall be adjusted to 33½ in. or as near as practicable thereto, but not exceeding 33½ in. When the construction of the car and the trucks precludes the common methods of adjusting coupler heights, such as raising the truck center plate height locally on top of the truck bolster, or placing fillers on top of or below the spring seats, the application of metal shims between the journal boxes and arch bars will be permissible. The use of liners between the male and female portions of center plates is prohibited where the vertical bearing surfaces are reduced by the insertion of such liners.

Couplers which are not within the limits of 31½ in. to 34½ in. from the rail not only constitute defects according to the rules of interchange but are also in violation of the requirements of the Safety Appliance Act.

Normal Clearance for Freight Car Couplers at Top and Side of Shank

In fitting up couplers in freight equipment cars it should be arranged to have 1¼ in. clearance on each side, that is, between the outside face of the shank and the inside face of the draft sill. The clearance between the top of the shank and the under side of the opening in the end sill is to be 3/4 in.

Cotter Keys in Knuckle Pins

Cotter keys are not to be applied to knuckle pins and couplers on cars other than hopper and fixed end gondolas.

Uncoupling Lever Connections Short

One of the very serious and easily avoidable items to be considered by inspectors is any lack of clearance causing restricted movement of the uncoupling connections so that when couplers take the full amount of slack possible the lock is lifted causing break-in-twos. This is often due to parts of the uncoupling mechanism becoming distorted and bent.

Coupler Yokes or Tail Straps

Coupler yokes are to be gibbed wherever possible to neatly fit the end of the draw bar butt and thus relieve the rivets of as much shearing stress as possible.

Coupler Yoke Rivets

The standard of practice for new car equipment and new couplers is to use 1¼ in. diameter yoke rivets. However, there are a number of couplers now fitted with 1⅛ in. diameter rivets requiring repairs at shops where these couplers can be reamed out to take the standard size, and this should be done. At shops where there are no facilities for changing couplers to take the larger sized rivet, it will be admissible to apply the smaller size. Also, when foreign cars appear on repair tracks which are fitted with 1⅛ in. diameter rivets, the same size can be reapplied.

Coupler yoke rivets should be headed on opposite sides; that is, one rivet will be headed on one side of the yoke and the other rivet will be headed on the opposite side of the yoke.

Coupler Carry Irons

All coupler carry irons must be held in place by at least four bolts if placed vertically and one through bolt with the necessary casting if placed laterally, all securely fastened in place. On wooden draft timber system cars, coupler carriers are to be gibbed or turned up on the ends to avoid the draft sills splitting or breaking away.

Safety Appliances

All safety appliances should be closely inspected and known to be in proper condition, and if not, prompt and proper repairs should be made, remembering especially that couplers must not measure more than 34½ in. from the top of the rail to the center line of the head or less than 31½ in. when the car is empty. Any defects or combination of defects which would cause a coupler to be inoperative, hand brakes, hand-hold, sill steps or other parts to be found covcovered in the rules relating to the inspection of safety appliances must be carefully considered. Passenger train cars used in freight or mixed service must be fitted with uncoupling attachments operative from the left hand side of the car to conform with the rules for freight cars.

Cars, whether loaded or empty, having safety appliance defects must have such defects repaired immediately upon discovery and will not be offered in interchange. If it is necessary to move the car to the shops for repairs of safety appliance defects, it must be moved to the shops of the company upon whose line it became defective.

Equipping Cars with Safety Appliances

Close attention is essential in the matter of giving proper attention in the equipping of cars with safety appliances, both foreign and system. Whenever system cars are loaded and it is found they are not equipped with safety appliances, if routed to some foreign railroad, the routing and destination must be ascertained so that the matter can be taken up with the foreign railroad to have them equip our cars. We must also equip foreign cars on our road, rendering a bill against the owners for the expense of doing the work.

Third of a series of articles on this subject by Mr. Sillcox. Copyright by the Simmons-Boardman Publishing Company.

Hand Brakes

Each car shall be equipped with an efficient hand brake, which shall operate in harmony with the power brake thereon. The hand brake may be of any efficient design, but must provide the same degree of safety as the design shown on Plate A of the Safety Appliance Standards.

Brake Shaft

The brake shaft shall be made of wrought iron or steel not less than 1¼ in. in diameter, without weld, and provided with a drum and trunnion. The drum shall not be less than 1½ in. in diameter and the trunnion not less than ¾ in. in diameter. The shaft is to be held in position with a cotter key or ring. The upper end of the shaft is to be arranged to hold the brake wheel with a square fit, not less than ⅞ in. and of a nominal taper 2 in. in 12 in. and is to be threaded to such an extent as to provide for not less than a ¾ in. nut. The end of the shaft shall be riveted over or held in position by a lock nut or suitable cotter to secure the nut.

Brake Chain

The brake chain shall be made of wrought iron or steel, not less than ⅜ in. in diameter with a rod link of not less than 7/16 in. and is to be secured to the brake shaft drum by a hexagon or square head bolt, not less than ½ in., the nut of which must be securely riveted over.

Brake Shaft Seat or Step

The brake shaft seat or step shall be held in position by a stirrup of such design that it will not permit the brake chain to drop under the shaft, U-shape preferred.

Brake Step or Foot Board

If a brake step (foot board) is used, it shall be 28 in. in length. The proper clearances for this brake shaft must be provided so that the outside edge shall be not less than 8 in. from the face of the car and not less than 4 in. from a vertical plane parallel with the end of the car, the 4 in. measurement to be taken from a line passing through the inside face of the knuckle, when closed, with the coupler horn against the buffer block or end sill. The brake step is to be supported by not less than two metal braces, having a minimum cross-sectional area of ⅜ in. by 1½ in. or equivalent securely fastened to the body of the car with not less than ½ in. bolts or rivets.

Brake Ratchet Wheel

The brake ratchet wheel must be not less than 5¼ in. in diameter, with not less than 14 teeth, and is to be secured to the brake shaft by a key or square fit. If secured by a square fit, it shall be not less than 1 5/16 in. square. Provision must be made to prevent the ratchet wheel from rising on the shaft and disengaging the brake pawl.

Brake Shaft Support

When the brake ratchet is more than 36 in. from brake wheel an extra support must be provided to support the extended upper portion of the brake shaft and the extra supports shall be fastened by not less than ½ in. bolts or rivets.

Brake Pawl

The brake pawl shall be pivoted upon a bolt or rivet not less than ⅝ in. in diameter, or upon a trunnion. If the pawl is placed upon a trunnion, the pawl is to be secured by a bolt or rivet not less than ½ in. The brake pawl and brake shaft are to be connected by a rigid metal connection.

Brake Wheel

The brake wheel shall be made of malleable iron, wrought iron or steel, and may be flat or dished, not less than 15 in. in diameter, and is to be fastened to the brake shaft with a square fit in the hub; the taper to be nominally 2 in. in 12 in. The proper clearance provides for not less than 4 in. around the rim of the wheel and other clearances specified call for not less than 4 in. from a vertical plane drawn parallel with the end of the car and passing through the inside face of the knuckle, the coupler and knuckle to be in closed position with the coupler horn against the buffer block or end sill when this measurement is taken.

Location of Brake Shaft

Box and Other House Cars.—On the end of the car, to the left of and not less than 17 in., nor more than 22 in. from the center.

Hopper Cars, High Side Gondolas with Fixed Ends, Low Side Gondolas with Fixed Ends and Low Side Hopper Cars.—To the left of and not more than 22 in. from the center.

Drop End Low Side Gondolas, Drop End High Side Gondolas, All Tank Cars, Caboose Cars Without Platforms.—On the end of the car to the left of and not more than 22 in. from the center.

Flat Cars.—On the end of the car to the left of the center, or on the side of the car not more than 36 in. from the right hand end thereof.

Caboose Cars with Platforms.—On the platform to the left of the center.

Uncoupling Levers or Lift Bars

Uncoupling levers shall be made of any efficient design and may be single or double, without weld. They are to be located one on each end of the car. When a single lever is used, it shall be placed on the left side of the end of the car. Uncoupling levers shall not be more than 12 in. from the side of the car. Center lift arms to be not less than 7 in. long. The center of the eye at the end of the center lift arm shall extend not more than 3½ in. beyond the center of the eye of the uncoupling pin in the coupler when the coupler is against the buffer block or end sill. The handles of uncoupling levers shall extend below the bottom of the end sill not less than 4 in. If the handles are not constructed so as to provide for this, the minimum clearance which must be provided is 2 in. around the handle. The minimum drop for uncoupling levers shall be 12 in. and the maximum 15 in. The distance from the rail to the handle of rocking or push down type levers shall be not less than 18 in. from the top of the rail when the lock block has released the knuckle. Provision shall be made to prevent the inside arm from flying up in case of breakage by having a suitable stop provided. All uncoupling levers for the different classes of cars are of the same kind and dimensions, except those for tank cars without end sills. On these cars the minimum length shall be 42 in. measured from the center line of the end of the car to the handle of the lever.

Sill Steps

Four sill steps shall be provided of wrought iron or steel, without weld. The minimum cross sectional area must be ½ in. by 1½ in. or equivalent, with a minimum clear depth of not less than 8 in. and tread not less than 10 in. If the steps exceed 21 in. in depth, they must be provided with an additional tread. Sill steps are to be fastened with not less than ½ in. bolts with the nuts outside (where possible) and riveted over, or not less than ½ in. rivets. Sill steps are to be located one near each end on each side of the car, not more than 18 in. from the end of the car to the center of the tread of the sill step. The outside edge of the tread shall be not more than 4 in. inside of the face of the side of the car and the tread not more than 24 in. from the top of the rail.

The foregoing rules in regard to sill steps apply to all classes of cars except tank cars without side sills and tank cars with short side sills and end platforms. On such cars one step must be located near each end on each side under the side hand holds.

There are other classes of cars not covered by the above instructions, namely, tank cars without end sills, where the sill steps are to be located one near each end of each side flush with the outside edge of the running board, as near the end of the car as practicable. If these steps exceed 18 in. in depth, they shall be made with an additional tread and be laterally braced.

Two side door steps must be provided on caboose cars without platforms, the minimum length being 5 ft. and the minimum width 6 in., minimum thickness of tread 1½ in.; minimum height of back stop 3 in. and the maximum height from the top of the rail to the top of the tread 24 in. The steps must be located one under each side door and shall be applied and supported by two iron brackets having a minimum cross-sectional area ⅞ in. by 3 in. or equivalent, each of which shall be securely fastened to the car by not less than two ¾ in. bolts.

Caboose Platform Steps

Caboose platform steps of safe and suitable box design shall be located at each corner of all caboose cars with platforms. The lower tread of the step shall be not more than 24 in. above the top of the rail.

Ladders

Ladders are to be made of iron, steel or wood, not less than ⅝ in. diameter if of wrought iron or steel. Wooden treads are to be not less than 1½ in. by 2 in. of hard wood. Ladder treads may act as hand holds. Ladders and treads must be secured by not less than ½ in. bolts with the nut outside (where possible), riveted over, or with ½ in. rivets. If wooden treads are gained into stiles, ⅜ in. bolts may be used. The proper clear length of treads is not less than 16 in. on sides of cars and 14 in. on ends of cars. There are exceptions in the case of tank cars without side sills and tank cars with short side sills and end platforms. Ladder treads on such cars shall be not less than 10 in. and shall have not less than 2 in. clearance. When ladders are not equipped with stiles, or with stiles extending less than 2 in. from the face of the car, they shall be equipped so that the bottom tread on the inside end is fitted with foot guards not less than 2 in. high. Ladder treads shall be spaced not more than 19 in. apart. A variation of 2 in. is allowed from the top tread to the bottom tread of the side ladder. The distance allowed from the top tread of the sill step to the bottom tread of side ladders is not more than 21 in. on box and other house cars, the top treads of ladders to be arranged not less than 12 in. or more than 18 in. from the roof at the eaves. The top treads of ladders on coal cars are to be arranged so that they are not more than 4 in. from the top of the car. End ladders are to be spaced to coincide with the treads of side ladders, 2 in. variation being allowed. When the construction of the car will not permit the application of the tread of the end ladder to coincide with the bottom tread of the side ladder, the bottom tread of the end ladder must coincide with the second tread from the bottom of the side ladder. Ladders on different classes of cars shall be located as follows:

Box and Other House Cars, Hopper Cars, High Side Gondolas with Fixed Ends.—Not more than 8 in. from the right hand end of the face of the car, or not more than 8 in. from the left hand side of the end of the car.

Drop End High Side Gondolas.—Side ladders must be located the same as on box and other house cars (no end ladders being required).

Two ladders are necessary on tank cars without side sills and tank cars with short side sills and end platforms, when such cars have continuous running boards and four ladders on cars having side running boards, if so located as to make ladders necessary. Two ladders on cars with continuous running boards are to be located, one at the right hand end of each side. Ladders on cars with side running boards are to be located one at each end of each running board. One ladder at each end is required on caboose cars with platforms, but the dimensions are not specified. Four ladders are required on caboose cars without platforms, the same as box and other house cars.

The variation allowable in the location for ladders on caboose cars without platforms is as follows: If the caboose has side doors, side ladders shall be located not more than 8 in. from the doors.

The following classes of cars do not require ladders: fixed end low side gondolas, drop end low side gondolas, flat cars, tank cars with side platforms and tank cars without end sills (if these tank cars have high running boards making ladders necessary, the sill steps must meet ladder requirements).

Conference Rulings.

Automobile Cars with Swinging End Doors.—These cars may come under the head of cars of special construction, and the end ladders may be placed as nearly as possible to the designated location.

Ladders.—Spacing of Ladder Treads. The spacing of top ladder treads shall be taken from the eave of the roof at the side of the car, whether a latitudinal running board is used or not.

Ladders and handholes need not be applied to swinging side doors of gondola and ballast cars. Ladders shall be placed on such cars as prescribed for high-side gondola and hopper cars, with the sill step under the ladder, or as near under the ladder as the car construction will permit. The ends and sides of cars are to be equipped with handholds in the same manner as flat cars.

Horizontal End Handholds

Handholds shall be made not less than ⅝ in. in diameter from wrought iron or steel, without weld. The proper clear length is not less than 16 in., but there are exceptions where it is impossible to use 16 in., and 14 in. may be used. The proper clearance is not less than 2 in. Eight handholds or more are required on certain classes of cars (four on each end) and four on other classes (two on each end).

The following classes of cars require eight horizontal end hand holds: Box and other house cars, hopper cars, high side gondolas with fixed ends, low side gondolas with fixed ends and low side hopper cars.

These end hand holds on the above named classes of cars are to be located four on each end, two of which must be not less than 24 in. or more than 30 in. above the center line of the coupler, where the car permits, except where the ladder tread acts as a hand hold.

There are cars so constructed as not to permit location of hand holds as above specified, namely, some fixed end and drop end low side gondolas and low side hopper cars; these hand holds are to be placed not more than eight inches from the side of the car. The other four end hand holds are to be located on the face of the end sills, not more than 16 in. from the side of the car, projecting outward or downward.

Upon the following classes of cars there can be but four horizontal end hand holds, namely, drop end high side gondolas, drop end low side gondolas, flat cars, tank cars with side platforms, tank cars without side sills, tank cars with short side sills and end platforms, and caboose cars with platforms. The other classes of cars equipped with but four horizontal end hand holds are tank cars without end

sills. The hand holds on these cars shall be located on the running board, one near each side on each end of the car, or on the end of the tank not more than 30 in. above the center line of the coupler, not more than 2 in. back of the edge of the running board. If located on the running board these handholds must project outward or downward.

The horizontal end hand holds shall be located on caboose cars with platforms as follows: One near each side on each end of the car on the face of the platform end sill. The clearance of the outer end of the hand hold shall be not more than 16 in. from the end of the platform end sill. An additional horizontal end hand hold is to be provided for cars with platform end sills 6 in. or more in width, measured from the end post or siding and extending entirely across the end of the car. The proper length of these additional end hand holds is not less than 24 in., and they must be located near the center of the car, not less than 30 in. nor more than 60 in. above the platform end sill, fastened securely with not less than ½-in. bolts with nuts outside (if possible) riveted over or with not less than ½-in. rivets. They shall be located on caboose cars without end platforms, in the same relative positions as specified for box and other house cars.

Tank head hand holds are required on tank cars with side platforms. Tank cars without side sills and tank cars with short side sills and end platforms. Two hand holds are specified but are not necessary if the safety railing runs around the ends of the tank. They are to be of ⅝ in. in diameter, made of wrought iron or steel with not less than 2 in. clearance. They are to be located and fastened one across each head of the tank not less than 30 in. nor more than 60 in. above the platform or the platform on the running board. They must be securely fastened, not less than 6 in. from the outer diameter of the tank.

Vertical End Hand Holds

End hand holds (vertical) shall be provided on cars with platform end sills (described heretofore) being two in number, not less than ⅝ in. in diameter with the tread not less than 18 in. without weld. The proper clearance is 2 in. and they shall be located opposite the ladders not more than 8 in. from the side of the car and not less than 24 in. or more than 30 in. above the center line of the coupler measured from the bottom end of the hand hold and secured by not less than ½ in. bolts with nuts outside (if possible) riveted over, or ½ in. rivets.

Conference Ruling.

The law makes no distinction between passenger and freight cars, and hand holds must, therefore, be placed on the ends of passenger cars and cabooses.

Horizontal Side Handholds

Side hand holds (horizontal) shall be not less than ⅝ in. in diameter of wrought iron or steel without weld. Four are required The proper length and clearance of these side hand holds are as follows: The tread must not be less than 16 in. long with a clearance of 8 in. from the end of the car and must be not more than 30 in. nor less than 24 in. above the center line of the coupler where the car will permit.

The following classes of cars are so constructed as not to permit the location of side hand holds as above specified: some fixed end and drop end low side gondolas and low side hopper cars. Side hand holds are to be securely fastened with not less than ½-in. bolts and nuts outside (if possible), riveted over or with not less than ½-in rivets. Ladder treads may act as hand holds. The location of horizontal side hand holds is not the same on all classes of cars, the exceptions being: flat cars, tank cars with side platforms, tank cars without side sills and tank cars with short side sills and end platforms. On the above classes of cars they are to be located not more than 12 in. from the end of the car, one near each end, on the face of each side sill. The four horizontal side hand holds on tank cars without end sills are to be located one near each end on each side of the car on the running board over the sill step. They are to be placed on the running board, not more than 2 in. back from the outside edge, projecting outward or downward. When these hand holds are more than 18 in. from the end of the car, an additional hand hold must be placed near each end on each side not more than 30 in. above the center line of the coupler and the clearance of the outer end of the hand hold shall be not more than 12 in. from the end of the car.

Side hand holds shall be applied on caboose cars with platforms, one located near each end on each side of the car, curving downward toward the center of the car from a point not less than 30 in. above the platform to a point not more than 8 in. from the bottom of the car. The top end of the hand hold shall not be more than 8 in. from the outside face of the end sheathing. They must have the following length and clearance: minimum clear length, 38 in., and minimum clearance, 2 in.

Horizontal side hand holds shall be located on caboose cars without platforms as follows: one near each end on each side of the car, not less than 24 in. nor more than 30 in. above the center line of the coupler. The clearance of the outer end of the hand hold shall not be more than 8 in. from the end of the car.

Vertical Side Handholds

These hand holds are used on all classes of tank cars if equipped with safety railings, and there shall be four located one over each sill step, secured to the tank or tank band.

Conference Rulings.

Ladders and hand holds need not be applied to swinging side doors of gondola and ballast cars. A side vertical hand hold shall be placed on the corner post of such cars, as nearly as possible over the sill step.

Vertical side hand holds on ballast cars must be applied to the outside face of the corner post, i. e., the faces of same which are parallel to the sides of the car.

Side Door Handholds

Caboose cars without platforms require these hand holds. They shall be four in number, two curved and two straight, located as follows: one curved hand hold from a point at the side of each door opposite the ladder not less than 36 in. above the bottom of the car curving away from the door downward to a point not more than 6 in. above the bottom of the car.

One vertical hand hold at the ladder side of each door from a point not less than 36 in. above the bottom of the car to a point not more than 6 in. above the level of the bottom of the door. They must be not less than ⅝ in. in diameter of wrought iron or steel, with a minimum clearance of 2 in., securely fastened with not less than ½-in. bolts with nuts outside (if possible) riveted over or with not less than ½-in. rivets.

Platform Hand Holds

Caboose cars with platforms require these hand holds, four in number, one right angle hand hold located on each side of each end extending horizontally from the door post to the corner of the car at the approximate height of the platform rail, then downward to within 12 in. of the bottom of the car. They must be not less than ⅝ in. in diameter of wrought iron or steel, with 2 in. minimum clearance preferably 2½ in. They are to be securely fastened with bolts, screws or rivets.

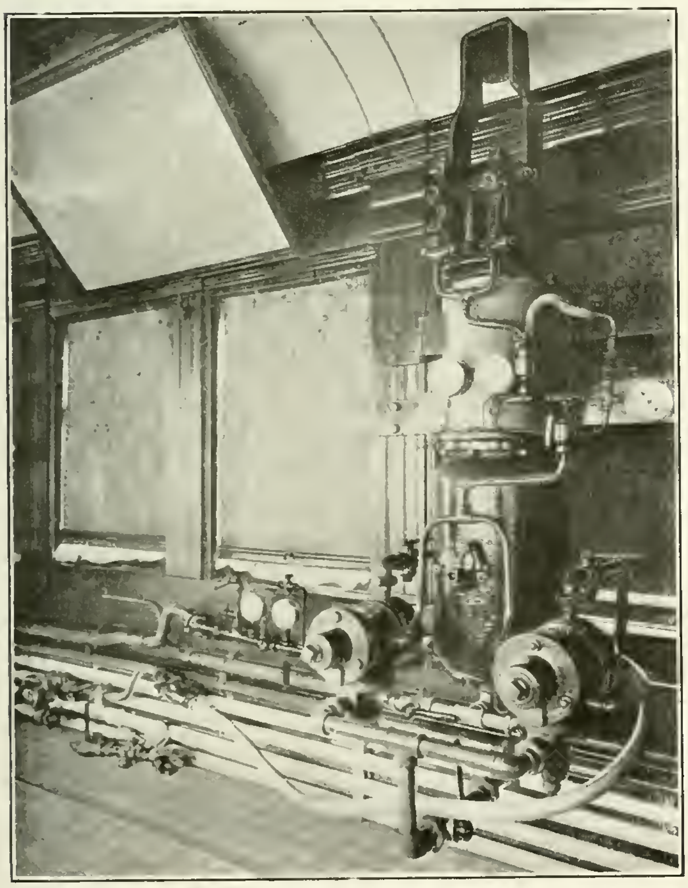
TEST RACK FOR INSTRUCTING AIR BRAKE REPAIRMEN

BY N. J. CLINE
Air Brake Foreman, Pittsburgh & Lake Erie

A novel and ingenious test rack installed in the air-brake instruction car of the Pittsburgh & Lake Erie is shown in the illustrations. This test rack is used for instructing air brake repairmen in the method of testing a car on the repair track for defects in the air brake equipment.

A 10-in. freight brake equipment stands vertically against the wall, with suitable pipe connections and gages to indicate resulting pressures and their changes. Two triple valves, one known to be in good condition and the other known to be in bad condition, or at least a condition that should receive attention, are also connected. The same is true of the pressure retaining valves installed on the top of the air cylinder, one of them being known as a good valve and the other as one needing attention.

To the left of the brake apparatus is a device for testing brakes on single cars, which is permanently installed as a part of this rack, but is, in detail, exactly like that used by the repairmen on the repair track.



The Air Brake Testing Device Installed in the Instruction Car

The repairmen are brought into the car in classes, and each man is asked to test out this car equipment, locate any defects, if they exist, and indicate what should be done to overcome them. Brake cylinder leakage can be varied, and either the good or bad triple valve or pressure retaining valve can be cut into the equipment.

The code of tests used with this rack is that for freight brake triple valves, which is as follows:

The tests are to be made with 80 to 90 lb. pressure in the supply line and with the single-car test apparatus.

Test for Testing Device.—Before coupling the testing device to the brake pipe hose, close cocks *1* and *2* and open the cock in the supply pipe. There should be no escape of air from the coupling at the end of the test device.

Coupling Device to Car.—Connect the coupling *A* to the brake pipe hose at one end of the car; to the other end on the opposite end of the car couple on a dummy coupling, which should be provided for this purpose. Open both angle cocks, then open cock 1 and charge the brake pipe and the auxiliary reservoir to 70 lb.

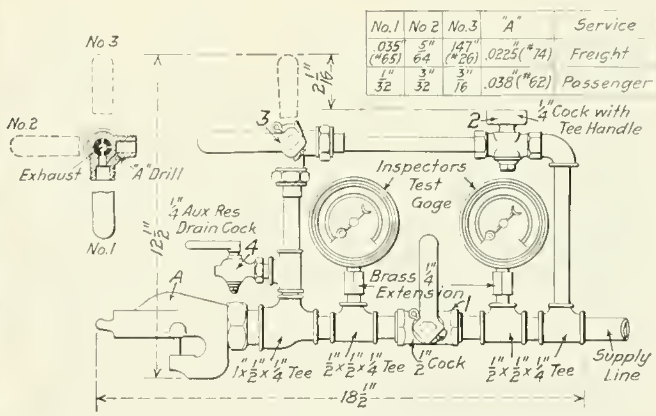
Brake Pipe Leakage Test.—Close cock *1*, open cock *4*, reducing the brake pipe pressure to 60 lb., then close cock *4*.

Observe the pressure on the brake pipe gage. Leakage in the brake pipe will be indicated by a drop in pressure, which should not exceed 3 lb. in one minute.

Auxiliary Reservoir and Graduating Valve Leakage.—During the brake pipe leakage test, if the triple valve releases the brake, it indicates either a leaky graduating valve or a leak from the auxiliary reservoir or into the brake pipe past cocks *1* and *2*.

Application and Release Tests.—Open cock *1* and charge the brake pipe and auxiliary reservoir to 70 lb. Then close cock *1* and move the handle of cock *3* to position No. 1, reducing the brake pipe pressure to 60 lb. The brake should apply before the brake pipe pressure is reduced to 60 lb. Failure of the brake to apply indicates that the triple valve should be removed for further investigation on the triple valve test rack.

Release Test.—If the brake applies, as specified in the Application Test, and brake pipe pressure is at 60 lb., open cock *2*. The brake should release in one minute. Failure of the brake to release in the time specified indicates that the triple valve should be removed for further investigation on the triple valve test rack.



Device for Testing Air Brakes on Single Cars

Service Stability Test.—Charge the brake pipe and the auxiliary reservoir to 70 lb., then close cock *1*. Move the handle of cock *3* to position No. 2, reducing the brake pipe pressure 20 lb. This test should not produce an emergency application of the brake. If an emergency application is obtained by this test, it indicates that this triple valve should be removed for further investigation on the triple valve test rack.

Emergency Test.—Charge the brake pipe and auxiliary reservoir to 70 lb., then close cock *1*. Move the handle of cock *3* to position No. 3, reducing the brake pipe pressure to 20 lb. This test should produce an emergency application. If an emergency application is not obtained, it would indicate that this triple valve should be removed for further investigation on the triple valve test rack.

It has been found that instruction by means of this rack has resulted in a far better understanding on the part of the repairmen as to the purpose of the tests made on the repair track and the importance of making repaired equipment pass

these tests before the car is released. With the exception of the single-car testing device, all of the apparatus was obtained from stock and required very little special application.

THE DEVELOPMENT OF PULLMAN TRAFFIC

Since the publication of the article in the January issue of the *Railway Mechanical Engineer* dealing with the needs of the railroads for additional passenger equipment, more data has become available which throws some light on the relative development of traffic carried in railroad and in Pullman passenger cars during the last 15 years and of the increase in the number of Pullman cars which has been made to keep pace with the growth of sleeping and passenger car traffic. In the absence of this information the discussion in the article referred to was confined to equipment of railroad ownership only.

During the ten years ending on July 31, 1915, the number of passengers carried in Pullman equipment increased from 14,969,219 to 21,489,301, or 44 per cent. During the same period the number of cars of all classes owned by the Pullman Company increased from 4,138 to 7,303, or 76½ per cent, but the performance of these cars as measured by car miles showed a proportionately smaller increase of 57 per cent. The number of car miles during the year ending July 31, 1905, was 444,986,296, while for 1915 it was 700,480,-779.

At the close of the fiscal year ending July 31, 1919, there were 7,622 Pullman cars of all classes which during the year had carried a total of 33,103,307 passengers and had made 734,031,856 miles. An increase in the number of passengers carried during the four years since July 31, 1915, of 54 per cent has been handled with an increase in the number of cars of 4.4 per cent and in the number of car miles run during the year of slightly less than 5 per cent.

It is unfortunate that there is no record of the number of passenger miles made by travelers in Pullman cars. To determine what the actual traffic increase has been, involves a knowledge of the average miles per passenger trip as well as a knowledge of a number of passengers carried. The best data available on this point are the average receipts per passenger as reported by the Pullman Company. During the seven years from 1911 to 1917, inclusive, the average receipts per berth passenger were $2.47, with a minimum yearly average of $2.43 and a maximum of $2.53. The average receipts per seat passenger were 62 cents for the entire period with a minimum yearly average of 60 cents and a maximum of 63 cents. An estimate of the actual mileage per passenger on the basis of these figures would be complicated by the fact that the average receipts per berth passenger are a weighted average of the rates for uppers, lowers, staterooms and compartments. The uniformity of the proportion of passengers for each of the two classes of Pullman cars and of the average receipts per passenger during the period mentioned seems to justify the conclusion that there was little change in the average miles traveled per passenger during the normal years preceding the war, and that the number of passengers carried may be considered approximately proportional to the number of passenger miles in each year.

It is evident that during the ten years prior to July 31, 1915, there was an increase in the number of Pullman cars greater than the increase in traffic seemed to demand. This is explained by the fact that during this period the construction of steel sleeping cars was developed to a practical point and coincident with the large increase in the number of steel passenger cars of railroad ownership a large number of steel Pullmans were built. These replaced the older wood equipment on many roads, particularly the large eastern roads, but the wood equipment was not actually retired from service. The number of cars in service in 1915, therefore, indicates an actual surplus of available equipment, part of which, however, could not be considered available for universal service. This is indicated by the fact that while the number of Pullman passengers per car per year was 3,620 in 1905, it had dropped to 2,940 in 1915. Likewise, the miles per car per year had decreased from 107,600 in 1905 to 96,000 in 1915.

Developments during the last four years, however, have materially changed this situation. With an increase in the number of passengers carried in Pullman cars of 54 per cent, there has been an increase in the number of cars of but little more than 4 per cent. It is true that this has been accompanied by almost no increase in the number of miles per car per year, each car making but 96,400 miles during the year ending July 31, 1919, as compared with 96,000 during the fiscal year 1915. There has, however, been an increase in the number of passengers per car per year from 2,940 to 4,340. This represents a 17 per cent increase in the number of passengers per car per year as compared with 1905, and such data as is available indicates that the ratio for none of the years prior to 1915 varied much from that of 1905. That this increase in service was effected without a material increase in the miles per car clearly reflects the results of the Railroad Administration's policy of filling sleeping cars, uppers and lowers alike.

There are two reasons which make difficult any attempt to arrive at a close estimate of the additional amount of sleeping and parlor car equipment required to meet the needs of the present and immediate future on the basis of past developments: first, the abnormal increase in the number of cars built during the decade prior to 1915, and second, the possibility of much greater utilization of the equipment than was ever developed during the pre-war years. Much of the wood equipment which has long been in use has rendered invaluable service during the war in the movement of troops. The gradual extension of the use of steel equipment, however, probably will considerably exceed the actual need for new cars, and it is inevitable that the surplus wood equipment must be of rapidly decreasing usefulness under normal conditions. It is also probable that with the return of the railroads to private operation the full effect of the lesson in efficient utilization of sleeping car equipment will not be retained by the public and there will be a demand for some choice of accommodations, which has been denied the traveler during the past two years. An increase in the number of cars sufficient to reduce the number of Pullman passengers per car to 4,000 on the basis of the business handled in 1919 alone would require about 700 additional cars, without considering the question of retirements, while to retain this ratio with an increase in traffic during the next few years proportional to the average increase which took place during the decade prior to 1915 would require almost 1,000 more.

This cannot be considered a close estimate, but it certainly may be considered as indicative of the fact that a large number of Pullman sleeping and parlor cars will be needed during the next few years to take care of the demand of the traveling public for a return of some measure of the choice of accommodations enjoyed before the war and to meet the inevitable growth in the passenger traffic of American railroads.

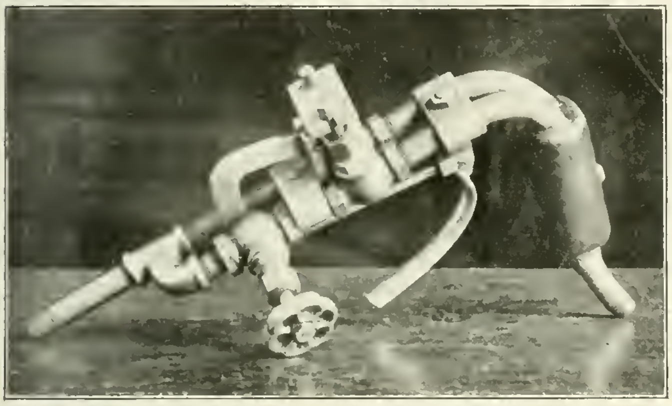
Spain Has Too Much Coal.—Spain, in common with most European countries, has a coal problem, but its situation is diametrically opposite to that of its neighbors; that is, it has a supply greater than the demand. Piled up at the heads and in the coal ports of Asturias lies a stock estimated at from 750,000 to 1,000,000 metric tons (metric ton equals 2,204.6 lb.), and the problem of the moment is how to dispose of this surplus.—*N. Y. Tribune.*

Paint Pipe Lines in a Cuban Car Shop

Unique Device for Mixing and Spraying Used with Great Success by the United Railways of Havana

BY J. P. RISQUE*

Claims for new high records in production being generally accepted with certain reservations, the statement that box cars are being painted in eight minutes will be received with interest. A further claim for painting 40 coal cars complete in 3½ hours would probably neither add nor detract from the reader's faith in the first statement. But if he were informed that these records had been maintained for over two years in a section of Latin-America in which he had long believed railroading, in the modern sense of the word, was an unknown art he would attach incredibility to the report. The fact is, however, that the United Railways



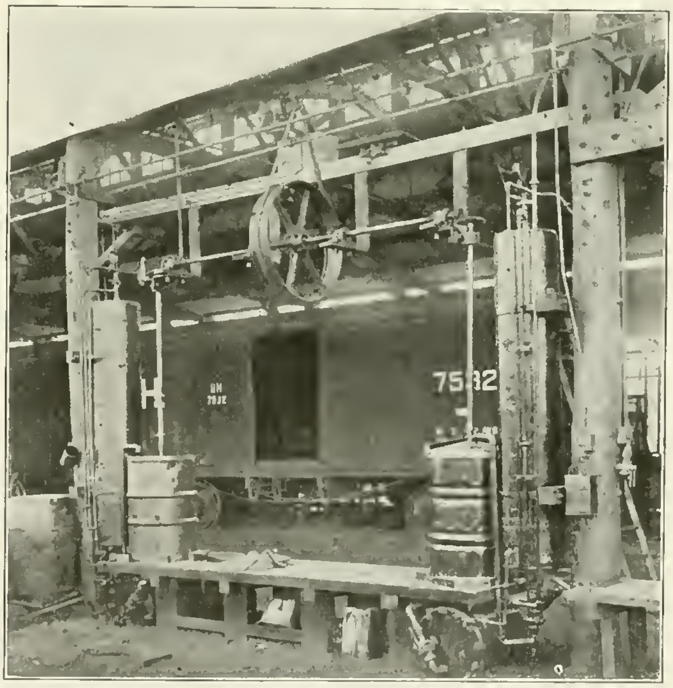
The Paint Gun Is Simple But Effective

of Havana have maintained this schedule at their Luyanó shops for the period of time mentioned.

The home-made paint mixing and distributing apparatus described in this article was originated and installed by Ben F. Elliott, master car builder of the aforementioned lines, and is doing efficient and regular business for the company every working day of the year. Coupled with the fact that its successful operation is not particularly enhanced by the temperaments of the operators to be found in these parts, most of whom would—and frequently do—relapse to the brush on the slightest provocation, the record can be truthfully said to be phenomenal. Constructed of such miscellaneous and second-hand material as is generally procurable in a large car plant, it is unique in design and simple in operation.

The machine's general arrangement is well set forth in the photograph which accompanies this description. It will be noted that the space occupied by the whole outfit is one which does not conflict in the least with the conduct of the business of the shop. The installation as arranged in reality comprises two paint machines—one for mixing and distributing red paint under air pressure, the other for black, the parts for one end being interchangeable with the other. Three principal features of the device mark it as a combination which is a distinct contribution to the art. The first feature is that of delivering paint ready for use in a spray gun anywhere along a pipe line 600 ft. long or even longer. The second, and perhaps an equally important one, is its function as a paint mixer and the consequent elimination of the tired workman and his hand-stirring paddle. The third point in the combination is the construction of the spray or paint gun, which differs sufficiently from stock varieties to make it noticeable.

The mechanical movement provided is solely for the purpose of operating the churns in the mixing tanks, power being derived from a two-horsepower electric motor driving a horizontal shaft through a flywheel. The shaft, mounted on suitable hangers and running in oil boxes fastened thereto, carries a bevel gear on its end. This gear drives its mate and revolves the vertical propeller shaft, which, anchored in a bearing near its top, seats in a collar in the bottom of the mixing tank—in this case an ordinary so-called "one-time" oil drum. A two-blade propeller is fixed near the base of the shaft and runs as close to the bottom of the tank as is practicable without scraping. The blades are pitched to force the agitation upward, and ¾-in. holes in the blades add to their mixing effect. The propeller blades are made from sheet iron and the relation of the motor driven shaft to the flywheel and proportions of gears, have been calculated to revolve the blades at a speed of from 50 to 60 r. p. m.



General View of the Churns and Pressure Tanks

Close-fitting removable sheet iron covers for the mixing tank admit of the introduction into the tank of the necessary quantity of paint and oil. When the covers are in place they prevent waste of paint by splashing.

The cylindrical tank below the churn is a receiver into which the mixed paint is allowed to flow by gravity upon the opening of the valve between it and the churn. The receiver is constructed of an old cast-iron flanged pipe and the heads are of wood, bolted into place as shown, with a sheet-iron outside cover.

Compressed air from the shop supply is admitted into the receiver through a reducing valve which cuts the pressure

*Mr. Risque is making a trip through Cuba and Central and South America as an editorial representative of the *Railway Mechanical Engineer*. In future issues we will publish other articles describing the interesting practices which he finds on the railways of Latin America.

down to 60 lb. per sq. in. The valve between the churn and the receiver is closed and the valve from the receiver to the pressure tank opened, and the paint is forced into the latter and out into the pipe line, which can be seen strung along the posts in the photograph. Stations are arranged at convenient intervals along the pipe line, and branch drop pipes bring the paint supply within easy reach of the operator. Painting a whole string of cars along the 600-foot line is then simply a matter of attaching the working hose carrying the paint gun, opening the valve and directing the spray.

As each station is provided with two drop lines with valves, one for a supply of red paint, the other for black, with double valves for air-pipe connections, painting in both colors on trucks and bodies can be carried on simultaneously, and the operation is not confined to one station. In the case of a rush, the number of stations operated is a matter of the supply of paint guns and hose.

Particular attention is directed to the construction of the paint gun, shown in the photograph, which is unique and consists merely of two brass pipes clamped together. The straight pipe carries air at 80-lb. pressure direct from the shop air line. The pipe which is seen to turn into the former carries the combination of paint and air at 20 lb. less pressure than the air pipe, or 60 lb. direct from the pressure tank via the pipe line. It will be realized that, although the paint in the line is under sufficient pressure of air to cause it to rush out of an open valve—in this case, the nozzle of the gun—it is, in reality, comparatively inefficient.

It is only through the energizing influence of its contact with an 80-lb. blast that the mixture assumes the required character to effectively carry it from the gun to the side of the car to be painted. The gun trigger, operated by the workman's finger, lifts a plate which bears against the stems of the two valves, one controlling the paint-line supply, the other the 80-lb. air pressure supply. Each valve is raised against the resistance of a small coil spring. As the spring on the straight air pipe valve is purposely somewhat weaker than the spring on the paint-line valve, it is obvious that in pulling the trigger the air line will open first. By this means the 80-lb. air blast is started first. Further pressure on the trigger causes the paint-line valve to yield and commence to admit its contents into the air blast, and the finished mixture rushes out of the end of the gun.

Accumulation of paint in the pipe lines is prevented by "blowing back" through the line. At either end of the 600-ft. run of pipes the two are joined by a tee. The third opening of the tee contains a nipple, with a cut-out valve on it. When this valve is opened, as well as either or both of the valves near the end of both red and black pipe lines, 80-lb. air is blown back through the line—or both lines if desired—

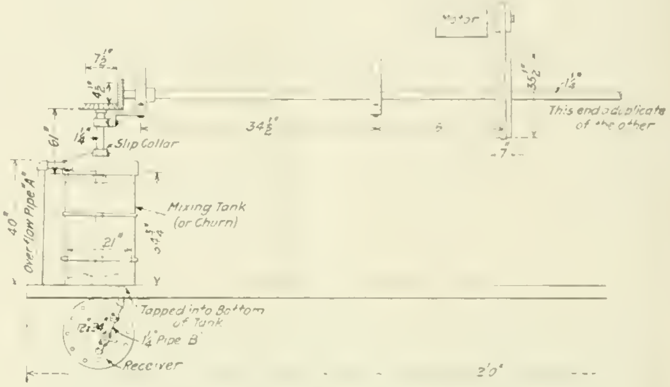


Fig. 1. Arrangement of Mixing Tank and Reciever

past the check valves, also near the end of the lines, and through the opened pressure tank valve into the pressure tank. A special discharge pipe and valve from the pressure tank carry the blown back residue to its original point, the mixing tank. If the paint line happens to become clogged, an incident which has not transpired in two years, provision is made for introducing five gallons of turpentine into the whole system to clean it out. Cleaning out the work hose, which is carried around by the operator and has the gun attached at one end and connects at the pipe line station and air valve at the other, is merely a matter of screwing a cap on the end of the spray nipple and pulling the trigger. The 80-lb. air will quickly blow the 60-lb. air and paint back out of the hose.

As the entire car-painting job is performed by this device without the aid of scaffolding, the saving on this item of cost is obvious. The performance of the machine in painting over 3,000 cars in the last 12 months is characterized by an

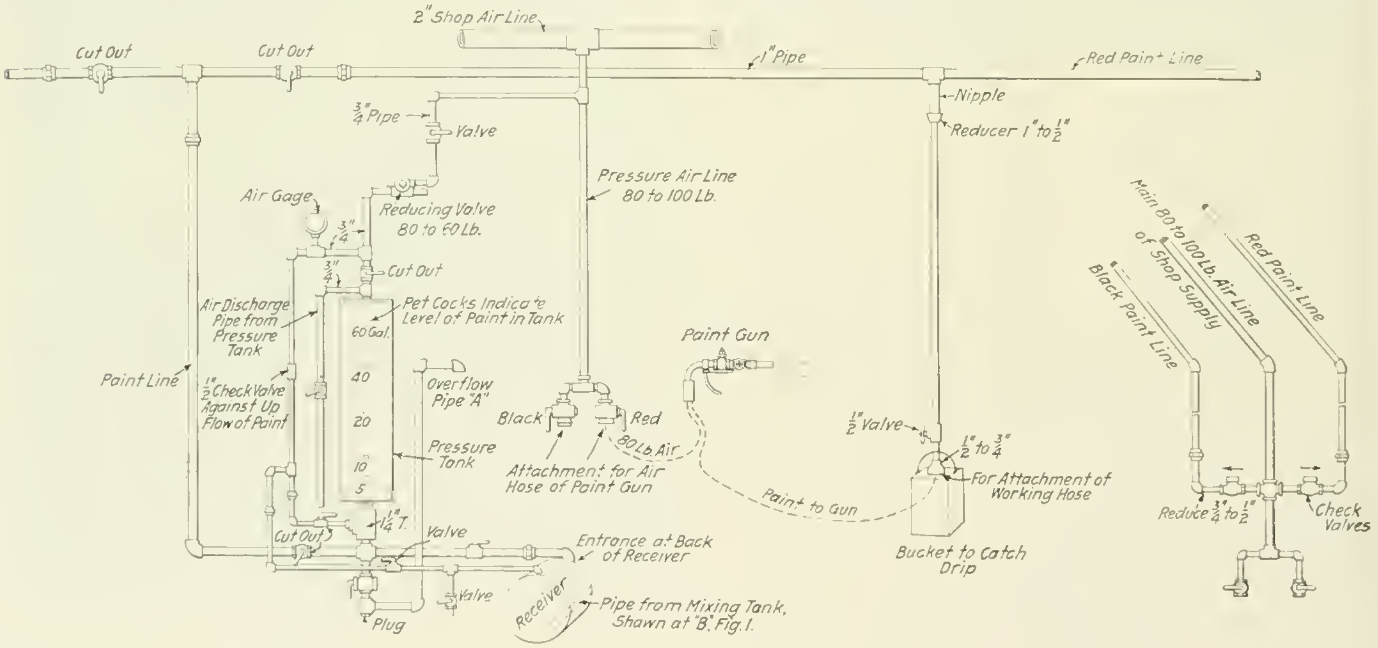


Fig. 2. Diagram of Paint Distributing System

absence of the waste of paint which so often accompanies the use of spray painters to a certain degree. No evidence of paint, either spilled or sprayed, is apparent anywhere along the run of tracks where the job is daily handled. The delivery from the tip of the gun is paint thoroughly atomized, its rate of flow does not vary, and the volume of effectual delivery seems to be sufficient to keep the operator on the move.

HANDLING WRECKS AND DERAILMENTS INVOLVING LOADED TANK CARS*

BY W. S. TOPPING
Assistant Chief Inspector, Bureau of Explosives

The loss and damage to life and property, due to the transportation of gasoline during 1918, exceeded many times the loss and damage due to the transportation of the unusually large volume of explosives required to meet war conditions. The average ratio of these losses is about twenty to one. The weight of gasoline shipped under normal conditions is about forty times the weight of explosives of all kinds, and during 1918 the weight of gasoline was about ten times that of explosives. When a comparison is made on the basis of actual weights shipped, during normal years the average transportation losses due to a pound of explosives have been about two times the losses due to a pound of gasoline, but during the year 1918, when abnormal quantities of explosives were shipped the losses due to a pound of gasoline have been two times the losses due to a pound of explosives.

The clearing up of wrecks of tank cars of gasoline and other inflammable liquids involves peculiar risks, owing to the large volume of contents in individual cars and the volatile and inflammable nature of these contents. Owing to the wide diversity of conditions that may exist in such wrecks it is not practicable to draw up regulations which will insure safe handling in all cases. The records of the Bureau of Explosives show instances of ignition of inflammable vapors reported to have taken place at varying distances from the points of leakage. In some instances these distances have been as great as 480 ft., while in others the distances, of course, have been materially less.

Gasoline varies in hazard from the wild and highly volatile casing-head gasolines to the ordinary refinery gasoline. Under ordinary atmospheric temperatures the former gives off many times the amount of vapor in a given time as does the latter. In hot weather all gasolines vaporize more rapidly than in cold weather, but even in the coldest weather gasoline gives off inflammable vapors in sufficient amount to ignite rapidly.

The vapor of gasoline or other inflammable liquids is much heavier than air and tends to form a layer along the ground and only mixes slowly with the air. The mixing with air is increased by wind. The vapor flows along the ground tending to follow the slope of the ground and settles in low places. It will not drift or flow to any extent against the wind, but may travel a considerable distance with the wind. Owing to variations as to volatility of gasoline, amount of gasoline exposed, temperature, contour of ground and direction of wind, it is impossible to fix any definite limit at which the hazard of ignition ceases.

In handling wrecks involving tank cars of gasoline, leaks should be stopped if possible, or the contents of the car transferred. While gasoline is actually escaping all lights and fires should be kept at a distance, this distance being much greater on the leeward side than on the windward. Any necessary lights should be kept in elevated positions. The passage of trains on adjoining tracks or the near approach of the wreck crane is unsafe, until the leakage can be controlled and the gasoline which has already escaped can be drained away and the saturated area covered with a layer of earth or cold cinders. Even after this is done sufficient time should be allowed to permit the evaporation of any loose liquid, and the diffusion of the vapors, so that they are no longer present in dangerous amount.

When the gasoline is escaping in large quantity, the situation is extremely dangerous and the first steps taken should be to police the location; to cause the removal or prevent the approach of all lights or fires other than closed electric lights; to keep all unauthorized people away. Next, steps should be taken to control the escape of gasoline, if possible, and if not, to dispose of the gasoline which has escaped, so that it will no longer be hazardous. This is generally best done by draining into holes dug in the ground, and then when the liquid has drained away, filling back the loose earth. Care should be taken to avoid permitting large amounts of gasoline to flow into sewers or water courses, as in this way the hazard may be carried long distances from the original point of trouble. After this the usual steps may be taken, using the precautions of keeping lights from the immediate neighborhood of the tank car and if possible bringing the wreck crane up from the windward side.

The precautions suggested will inevitably cause delay in the removal of wrecks, and opening the line; but there is no possible way of safely handling such wrecks while tank cars are leaking gasoline copiously, or gasoline which has already escaped in quantity is still uncared for.

The following general rules will serve as a guide for the majority of cases:

1. Post guards and keep all speotators away.
2. Locate all leaks and stop them if possible, using only electric flashlights or electric hand lanterns when lights are necessary. If open flame lights must be used keep them elevated as much as possible.
3. Dig holes and trenches to bury exposed and leaking gasoline that cannot be transferred promptly to tight containers.
4. Allow reasonable time after stoppage of leaks and burial of gasoline for vapors to escape from the wreck and vicinity.
5. Keep steam crane fire to windward as much as possible and not less than 500 ft. away until completion of work to this point.
6. First move to safety the least injured cars to avoid starting new leaks during handling by crane. When leaks are to be expected in handling, empty the car first either by transfer of contents to other car or container, or by drainage to a hole or trench in the ground for burial.
7. Do not allow trains to pass on adjoining tracks, especially on same or lower level, as long as gasoline is leaking or exposed in quantity. When allowed to pass keep fire doors and ash pan slides closed and draught shut off.
8. The placing of leaking tank cars for repairs in close proximity to shops where fires or naked lights are maintained must be avoided.

Special Precautions for Casinghead Gasoline

The foregoing refers particularly to ordinary refinery gasoline and other inflammable liquids of low flash point, but should not be taken to include casinghead gasoline, either blended or unblended. Such cars, under the I. C. C. Regulations, are required to show special placards on two sides of the dome and on the dome cover, reading as follows: "Caution. Avoid Accidents. Do not remove this dome cover while gas pressure exists in tank. Keep lighted lanterns away."

In handling situations involving such cars, the first procedure is to release very carefully any accumulated interior

*From a paper read before the sixth annual meeting of the Railway Fire Protection Association, held at Chicago, November 18, 19 and 20, 1919.

gas pressure. This should be done by raising the safety valve stem by engaging the end of the metal rod in the eyelet in the top of the valve stem and prying downward against the outer edge of the top of the spring case. Before doing this the tank should be carefully jacked into normal position, or so nearly as to bring the safety valve above the level of the liquid, other wise the liquid instead of the gas will be forced out. Not until the gas pressure has been relieved can arrangements be undertaken with safety to begin the transfer.

If the wrecked tank is not broken or leaking the contents can be transferred by air pressure. This is best accomplished by using a special dome cover with two openings through which pipes are tightly fitted. One of these pipes extends a few inches inside the dome and is used for the air pressure feed; the other passes to the lowest part of the tank and acts as a discharge. If a special dome cover is not available and a machine shop is located in the vicinity of the wreck the dome cover of the car can be prepared as described above in a short time.

Highly volatile products such as casinghead gasoline cannot be transferred in the usual way by an ordinary vacuum pump. As soon as such a pump creates a partial vacuum the vapor from the liquid fills it and for this reason only vapor will come through. A pump can be used, if connected so that the liquid will flow from the tank to the pump by gravity. Before connecting the pump with the bottom outlet relieve all pressure through the safety valve, and then remove the dome cover and carefully verify the setting of the outlet valve stem.

If it is necessary to bury the liquid dig trenches deep enough to keep all of the liquid well below the surface of the ground.

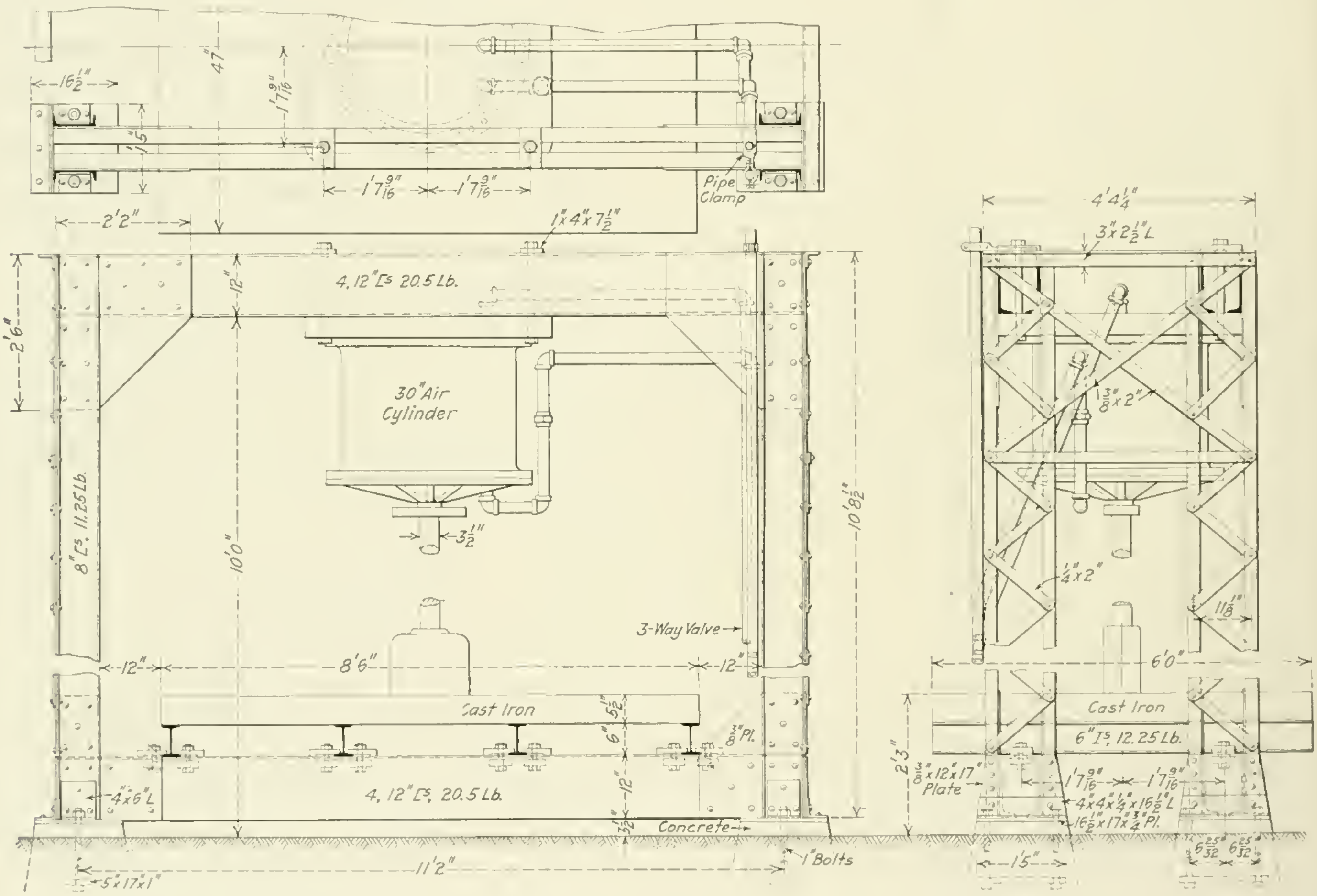
AIR PRESS FOR STRAIGHTENING STEEL SHEETS

BY NORMAN McLEOD

The reclamation of distorted steel parts of cars, particularly the bent sheets of steel cars, is a most important feature in economical car repair work and is being given considerable attention by car repairmen. The air press shown in the drawing is a development brought about by the need of an efficient means of straightening bent steel sheets.

Similar devices have been used, but the press shown has been very successful and a number of them have been built for use in various railroad repair shops.

The framing of this air press is built up of steel channels and angles, firmly braced with gusset plates and steel lattice work, and is supported on a concrete foundation. The bedplate of the press is of cast iron and is 8 ft. 6 in. long by 6 ft. wide. It is 5½ in. thick and rests on four 6-in. I-beams, making a most ample and rigid bed for any part of a car that may require straightening.



Construction of Air Press for Straightening Steel Sheets

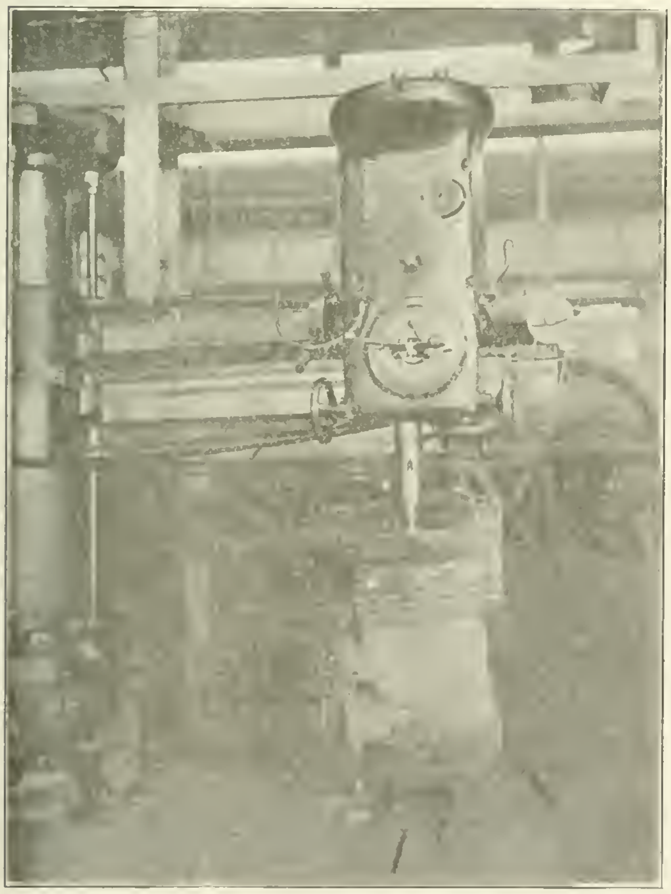
The air cylinder used in this design is 30 in. inside diameter, with a piston mounted on a 3½-in. piston rod, to the end of which is attached the ram or hammer used in straightening a distorted piece. The cylinder is secured to the top cross members of the press frame by four bolts extending upward between the channels. A three-way valve with suitable piping provides for the admission of air to either side of the piston and for the exhaust of the air to the atmosphere.

The space between the side frames is 10 ft. 6 in. and the head room above the bedplate is 7 ft. 9 in., providing ample room for the operators and permitting the use of a sledge if necessary.

NOVEL CHUCK ARRANGEMENT FOR HOLDING DRIVING BOX

BY GEORGE BARNSTRICKER

One method of taking up the side play on driving boxes is to recess the face of the box on a boring mill and pour on molten brass, which is later machined to the desired thickness. In recessing the side of the box it is usually



Chuck Set at 30 deg. Holds Driving Box While Holes are Drilled in Hub Face

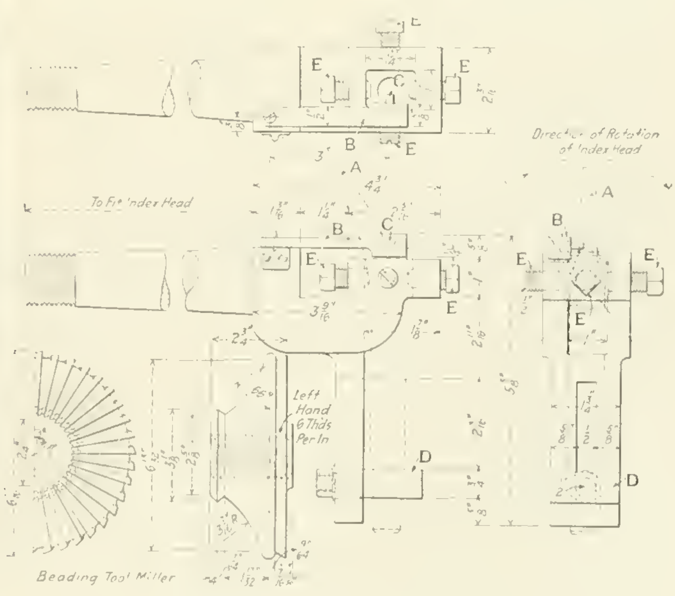
cut under in order to hold the brass in place after it has cooled off. It was found in actual practice, however, that this form of attachment was not sufficient, and a series of 32 holes were drilled around the face of the box at an angle of 30 degrees. These holes need not be of any exact size, but 5/8-in. holes by 5/8 in. deep will be found to give satisfaction and insure the brass hub liner remaining in place.

For the purpose of drilling this series of holes in the driving box face at an angle of 30 deg., the arrangement shown in the illustration will be found a material aid. Two pieces of 5/8-in. by 2½-in. iron are bent to an angle of 30 degrees, and bolted to the base of the drill press, where the driving box drilling work is usually done. An ordinary lathe chuck of large enough capacity to take the largest driving box, as shown, is now mounted on the two pieces of iron and a boss underneath the chuck holds it in place, but does not prevent its rotation. In actual practice, the driving box is mounted on the chuck and clamped as shown in the illustration. The 32 holes are then drilled in the face of the box at a constant angle of 30 degrees by simply revolving the chuck after each hole has been drilled.

JIG FOR MILLING BEADING TOOLS

BY C. W. SCHANE
Instructor of Apprentices, Erie Railroad

The beading of locomotive flues requires careful and accurate work to secure smooth, tight beads so that there will be no leakage and little tendency for honeycomb to form and stop the flues. To do accurate work in beading over the ends of the flues it is necessary to have properly milled bead-



The Beading Tool Miller and the Jig

ing tools. A jig for use in making such tools is shown in the illustration. This jig is made to screw into the index head of the milling machine and when the beading tool is being cut, is adjusted to the proper position to produce the required shape of the tool.

In the drawing the beading tool *A* is shown in outline. A small dog or stop *B* permits the exact duplication of adjustment of the tool by means of the projection or pin *C* on the dog. To adjust a tool in the jig for the milling operation a tool is inserted through the rectangular hole in the top of the jig, with the shank of the tool resting in the adjustable support D. The dog B is then thrown into place at the tool secured in the desired position by the set screws E.

The use of this jig has not only produced beading tools of greater accuracy than it was possible to make by ordinary hand methods, but it has reduced the cost of manufacture from 60 cents to 8 cents each, a saving of 52 cents on each tool.

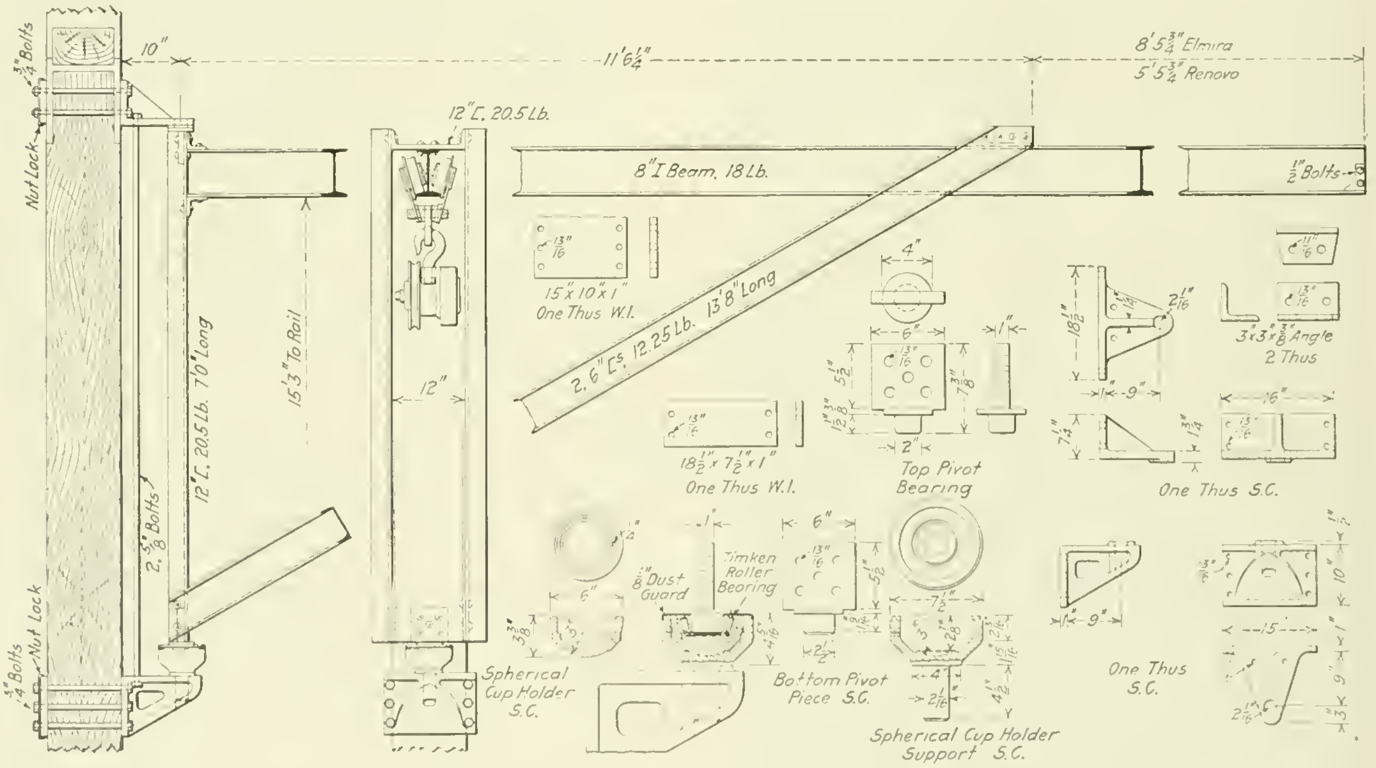
A ROUNDHOUSE CRANE

BY A. P. SHARP

A jib crane for use in roundhouse work was described on page 205 of the April, 1919, issue of the *Railway Mechanical Engineer*. This crane, as first designed and built, facilitated repair work in the roundhouse, but it was found that the friction which developed at the pivots was so great that it seriously interfered with the operation of the crane. To overcome this trouble, those cranes which had already been built were equipped with roller bearings, greatly increasing their utility. The service obtained from these cranes led to a further improvement, and the new design is shown in the accompanying drawing.

In the present type the jib boom was made of an 8-in. 18-lb I-beam instead of a 6-in. 17.25-lb. I-beam as in the original design, a single vertical 12-in. 20.5-lb. channel instead of two 6-in. 8-lb. channels, and the brace is formed of two 6-in. 12.25-lb. channels instead of one. As in the original design, the trolley travels along the I-beam, but the length of this boom, and consequently the range of the crane, has been increased considerably, making it possible to handle more parts at various stages of roundhouse repair work without the necessity of moving the locomotive to come within range of the crane boom.

The castings and other fittings are substantially the same as in the first design, only such changes being made as were necessary to provide for the greater range and for the roller bearings. These cranes installed at alternate posts in the roundhouse will increase the capacity of the house for repair work and will soon return the cost of construction.



Details and Installation of the Roundhouse Crane

Piece Work—Pro and Con.—That the hourly wage basis of payment of wages has not produced as good or satisfactory results to either party as some of the special piece work or premium plans that were previously in vogue, is being more or less generally conceded. A careful canvass made recently by the New York Sun among manufacturers to determine the working out on production of enforced shorter hours and increased wages confirmed the belief of economists that its results are not as beneficial as expected. The theory has been that the worker can produce better goods if allowed to work fewer hours a day than his energy is capable of, providing he received increased compensation for the fewer hours, but the great fault of the scheme is that it does not take into consideration the mental attitude of the individual, and where all are on an equal basis and the sloth receives the same pay as the industrious worker, the latter loses his ambition and allows himself to fall to the level of the slower and lazier partner at his work. In the end the ambitious worker is the loser in following this false precept. Progress cannot be made by retarding production and production cannot be increased by slowing down the individual worker. A far better standard is found in a wage system depending not on a fixed scale for the class of work done so much as in the amount of work produced, which makes the laborer worthy of his hire and puts the individual strictly on his own feet. It is interesting to note that in a recent wage decision the arbitrator denied the demands for the abolishing of piece work. All this would tend to indicate that the turning point has been reached and that a realization that the wages labor receives must be made out of the work labor produces, will bring recognition of the fact that increased and scientific production and payment for same under an individual system, which would give the greatest award to the greatest producer, must go hand in hand.—*Proceedings of the Car Foremen's Association of Chicago.*

The Old Way and the New; A Car Shop Story*

Autocratic Management Proved a Failure, But An Entire Change of Policy Brought the Desired Results

BY THEODORE RUDOLF

THE first year of our part in the world war had just come to a close when Sidney Stevens stepped from the train in a small Southern town. Endowed with youth, strength, good looks and an active mind, but of a roving disposition, he could never stay long in one place, but drifted about as his fancy dictated. Never having learned a trade fully or having acquired more than a superficial school education, his ambitious mind could not take root in the general occupations open to him. Raised on a farm, an orphan without family ties, he had run off in his fifteenth year to follow the lure of the wide world and had worked his way in numerous callings.

An inborn love for mechanics had kept him for the most part engaged in mechanical work, but having had no training, he could never attain any higher degree to satisfy his ambition, and soon would quit, dissatisfied. Drifting into the war industries, he had worked in several munitions and other factories, but the automatic, soul-killing sameness of his daily tasks there irked his independent spirit to distraction. Earning much more money than his simple habits required, and without any friends of more refined tastes, he would squander it in reckless fits of riotous living, which would only leave him with a greater feeling of dissatisfaction with himself and the world in general. After one of these wild sprees, disgust with it all took him so forcibly that he quit his job and boarded a train south, with the intention of putting as much space between himself and his former haunts as possible.

Awaking one beautiful Southern morning in the train, the country and this little town took his fancy and he decided to terminate his travels on the spot. Aimlessly drifting out from the depot, he noticed the railroad shops nearby, and his love for all that was mechanical tempted him at once to look them over and led him directly into the car shops His keen, observing mind soon found much of interest. Watching the men here doing carpenter work, there drilling holes in steel beams, others welding truck bolsters or riveting plates, he was quickly struck with the many-sided operations in this work, which would surely leave much to a man's individual creative mind and ingenuity. On inquiry he learned from the men that at the present time help was so badly needed that almost anyone who could swing a hammer would get a job, without regard to previous experience. They advised him to see the foreman of the car department or the general foreman about it, and pointed out the latter to him, who happened to be standing nearby. Sidney at once followed the advice, and soon had his paper and check number, showing that he was employed as an inexperienced car repairer.

Having secured a boarding place, he returned in his overalls, ready for work, and, approaching the foreman of the car department, tendered his paper and reported ready for duty. The foreman, a gruff looking, elderly man, hardly gave him a look, took the paper and walked off, as if he had some important business elsewhere. Sidney waited in the office, and during the next hour the foreman passed by him several times without paying the slightest attention to him. Not knowing what to make of this, Sidney asked one of the men working nearby how he could get started on work.

"How did you happen to be hired?" asked the man.

"Why," answered Sidney, "I asked the general foreman for a job and he hired me and sent me here."

"Well," laughed the man, "that is just where you rubbed the boss against the grain. You see, our boss is a good old man all right and would not hurt a cat, but he has a chronic grudge against himself and all the world, and he's so jealous of his little authority that he's always afraid some one above him is meddling and stepping on his toes. If you'd asked him first for a job he would have sent you to the general foreman for him to hire you, and you would be O.K. with him. Now you'll have to be patient until he softens up again, and I'll tell you what'll happen. You just stay right there and look as if you don't care how long you stay; your time goes on the payroll just the same. First thing the boss will bounce down on you and give you a long lecture about the G. F. and everybody else trying to interfere in his business, and give you to understand that it's a pity for the company that they let them do it, since he himself is the only one that knows anything about the car business, but is not given a chance to show it, and nobody appreciates what a fine car shop foreman he is and how hard he works, and so on. Then, when you are well soaked with all this valuable information about himself, he'll put you to work with one of the men and pay no more attention to you, except that he'll tell some of us fellows that the general foreman has again shipped him another greenhorn that doesn't know a bolt from a 20-penny nail. But don't let that or anything else that seems strange around here worry you. As long as you're hired you're on, just so you do something to look busy."

It soon turned out exactly as the man had predicted, and after being thoroughly inundated with the foreman's troubles he was put to work as partner to an old-timer—a ruddy, rough-looking Southern cracker named Ben Simmons. On short acquaintance Ben proved to be an honest, whole-souled, good companion, who knew his business thoroughly. Good-natured, but with little education or refinement and having spent the greater part of his life in car shops, he had the pride and enthusiasm of his trade that is bred by ignorance of all other callings. Soon he had taught Sidney the tricks of the trade and felt proud of his willing and quick-learning pupil, so that together they turned out work in excess of the other men, and took commendable pride in the fact.

Sidney's many-sided experience soon showed him that there was notihng extraordinary for one of his bright and observing mind in his new calling, even if the foreman and other men tried to convince him that it would take years and years to learn all they claimed to know about it. Often he would try to get some more information about different phases of their work from the foreman, but only received scant replies, given in such a sarcastic way that he desisted and tried the assistant foreman. This man, he soon noticed, was willing enough to give him information, but, like the rest of the officials, seemed to be always afraid to be caught by one higher in rank and lay himself open to the suspicion of knowing too much.

When talking to Ben about this, he laughed and told him not to pay any attention to fellows that thought more of their job than their work any time.

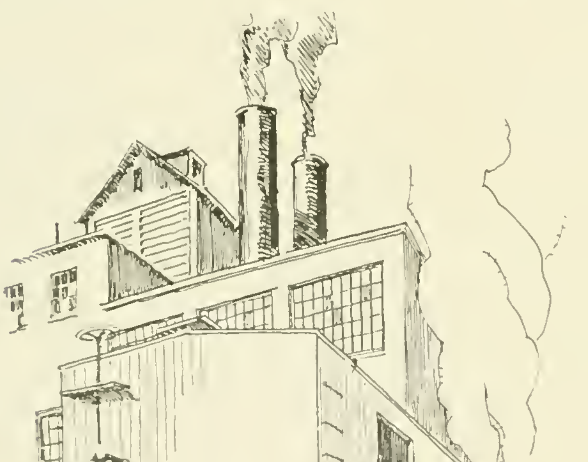
"Don't you never," said Ben, "look for any satisfaction for what you do if any of them can grab it away. When we used to work piece work times were lots more satisfactory

*Entered in the *Railway Mechanical Engineer's* prize story contest which closes on April 1.

than this, because then your pay check would show whether you were doing something or not. A man had to produce the goods to get anything then. Now any old clodhopper can get in here and soon gets the same wages as we old-timers get, when half of them ain't worth 15 cents a day. Just look at those two fellows over there, working their second day on a pair of draft timbers, the same as we got out in four hours yesterday. But what did we get for making such time? The boss sneered about it, saying that we might have used better timber, when he himself sent us the stuff here to make them. And there he stands, talking with those fellows now for a half hour about some philosophy or other that nobody understands, but all listen and the work just waits till he gets done. When I go to him and ask him to rush us some material we need badly, he'll tell me I am always meddling and interfering in the yard. I'll tell you this is the worst place for asking any questions of anybody, because everybody is scared his answer might be held against him by some one higher up, so you see everybody pussy-footing about the other fellow trying to find out things without having to ask questions."

Sidney, listening to these wise counselings, had a slight feeling of disgust at the hypocrisy of the whole works.

Suddenly his attention was attracted by seeing a young girl crossing the shop tracks nearby, and at the same time he noticed an empty box car silently coming down the same



He Noticed an Empty Box Car Coming Silently Down the Tracks

track, unnoticed by the girl. In a flash he realized that a car with a broken coupler had parted from the switching train and, rolling down the slight incline, had almost reached the unsuspecting girl. Like a shot he jumped, picked her up unceremoniously and deposited her on safe ground. In her surprise the girl struck out and cut a long gash across his forehead with the edge of her handbag, but did not utter a sound. There they stood now, staring at one another—Sidney speechless with embarrassment at having dared to pick up and rough-handle this wonder of womanhood. Small and shapely, a pretty head within a glory of gold-tinted hair and a pair of eyes that seemed to search his soul, she appeared to him, with his limited knowledge of refined womanhood, the very embodiment of an angel from heaven.

Now the shadow of the passing car fell on her and, turning about, she quickly realized what this man had done for her. She turned pale at the thought of the fate she had just escaped and, turning again to thank her rescuer, she looked into a face so comical with smears of blood, dirt and embarrassment that she broke out into a silvery laugh. Quickly recovering herself, she thanked him for what he had done in such an open-hearted way that Sidney quickly found his poise again. He waived aside all thanks, explaining how the car happened to be loose.

"It's that old fool of a foreman's fault," he said. "He is

She Suddenly Appeared in Front of Him on the Street

directing the switching and should have watched out for this car."

"No," said the young woman, "it was my fault for trusting so much to the blue flag, laying there now under the car, and not keeping a watchful eye on all tracks, as my dad,, who happens to be that 'old fool of a foreman,' has taught me."

With that she laughed her silvery laugh again and was gone before Sidney recovered himself.

Returning to his work, he was glad that no one seemed to have seen his encounter, but he was quiet and like one stunned. Never in all his life had a woman affected him like this. He told himself that it must be because he had never come into close contact with any real lady before, but at the same time he knew that he had, without a second's notice, fallen hopelessly in love with Ellen Goodell, his foreman's daughter.

He did not see her again until two weeks later, when she suddenly appeared in front of him in the street and stopped him with outstretched hand and a hearty greeting. Obviously admiring his gentlemanly looks in his street clothes, she soon put him at ease with her merry talk, and before he knew how it had happened he had accepted her invitation to call on her at her home. There he learned that she had lost her mother and was her father's only companion and housekeeper.

Her father paid no attention to him, merely saying a gruff "Good evening" when he passed through the room, while

Ellen told Sidney not to pay any attention to this; that her father was a dear old bear with all his grumpiness.

Both being honest and open-hearted, Sidney and Ellen soon exchanged experiences and confidences like old friends, but Sidney could not overcome the feeling that this lovely girl, judging from her talk, belonged to a different sphere socially, even if his democratic spirit would never admit that about her father. Yet when he studied her father's ways and those of the other foremen about the shops he could not but see that they tried to surround themselves with a spirit of social superiority that was greatly distasteful to his democratic nature.

Meantime the war advanced, conditions all about changed continually, the men grew restive and nervous, being harrassed continually by their union leaders, the advancing cost of living, continued calls for war relief contributions and war bonds. Argument and gossip filled up their time and production lagged more and more. The Railroad Administration, needing cars badly, tried in every way, from stirring the men's patriotism to bringing pressure on them through their foremen, to increase the output, without great results. Many inexperienced men were put to work, the foremen grew harsher and the men more nervous. Cursing and ugly brawls became more common every day.

Sidney, in his sincere desire to do right, worked harder than ever, but only earned sneers from the men and a contemptible smile from his superiors for trying to outdo the rest of the gang. Small controversies with members of the supervising force, when he tried obstinately to uphold what he thought right, only made more enemies for him. The gang foreman who checked his work was an old employee, who prided himself on his great knowledge and on his unimpeachable honesty towards the company in the smallest details. In checking a car for Sidney he questioned the weight and size given by him for a certain iron on the car, and launched into an argument that included the foreman, Sidney, his partner Ben, and two laborers.

Sidney, getting tired of it all, suddenly asked the gang foreman where all his great honesty towards the company came in when the possible difference in the weight of the iron would amount to not more than two cents, while here between the six of them they had already wasted over two dollars' worth of the company's time and had accomplished nothing.

Incidents of this sort being of daily occurrence, Sidney grew more and more dissatisfied with his surroundings. His friendship with Ellen had grown meanwhile into a deep and adoring love on his side, and Ellen herself felt more deeply for him than she would admit to herself.

There seemed to be always some barrier between them which kept them from going out in public together or to mingle in the same sets socially. He saw her alone only at her home, and she would often try then to induce him to give up his present work and take what Sidney called "a white shirt and collar" job. He treated these attempts of Ellen's lightly, but could not overcome a slight feeling of unpleasantness over these trials.

One day, after an exceptionally unpleasant argument with his foreman, who tried to impress him with his superiority when Sidney knew himself to be in the right, he carried his shop troubles into his conversation with Ellen. An argument resulted, which grew to fever heat when Sidney denounced her father's ways and actions, Ellen taking her father's side uncompromisingly. Forgetting all caution, she claimed that her father and she stood so high above an ordinary car knocker that they would lower themselves by yielding an argument to him and that he had better try to get into some more gentlemanly position or else let her alone. In a rage Sidney grabbed his hat, left without a word, and the next day had abandoned his job and the town. He volunteered for the army, was accepted, and before long was at the front in France as a car repairer with the railroad forces, where events did not leave him much time to think over his shop experiences.

Twenty months later, when discharged at last and looking about for work, Sidney was given mileage to his place of recruiting, and so happened to return again to the town of his former labors. Seeing the old place once more awoke many recollections, and almost unconsciously he left the train, to begin where he left off. There was a crowd of people at the depot looking for returning soldier boys, and he was at once hailed by many old acquaintances.

Suddenly his heart stood still as he thought, there in the crowd away back, he saw Ellen Goodell, pale and thin, dressed in black, looking at him in a far-off, strange way. His first impulse was to run and embrace her; he had never forgotten her for a moment in all their time of separation. Noting that she made no move, but stood as if frozen to the spot, the recollection of their parting came over him suddenly, and he turned about and walked off without a sign of recognition.

Calling at the car shops the next day, Sidney found many of his former co-workers and was most cordially received by all, until he ran into his old partner Ben, who received him

There in the Crowd, Away Back, He Saw Ellen Goodell

enthusiastically and urged him at once to come back to work with him, saying that since he was an ex-soldier he was assured of a job.

"Yes," said Sidney, "but what about my old friend Goodell; do you think he will take me back?"

"Well," answered Ben, "the old man died of the 'flu' eight months ago and things have been turned inside out around this yard since then. You'll sure like it here now. There is our new foreman, Mr. Woods; go and jump him right now, get your job and come back and I'll tell you all about it."

Sidney approached the man pointed out, a slight but wiry and alert man, slightly gray and with a pleasant, open face. No sooner had he stated that he was an old member of the force and looking for work than the foreman took his hand, congratulated him on his safe return and told him to go back to his job just as soon as he wished to start again. Then he engaged him in some pleasant conversation about his war experiences, but Sidney noted that whenever one of the men approached with a question or request he would stop at once, attend to the man in a short, precise manner, but with a smile on his face, before going back to his conversation with him. When released, Sidney hurried back to Ben and voiced his surprise at the cordial reception he had received.

"Now you are talking," said Ben, "but, oh, boy, you have not half found out yet all the change in this old place. You remember how we used to peg along here with poor equip-

ment and tools, short material to work with, no encouragement from the bosses, petty jealousies among the men and union squabbles. Well, it kept on that way from bad to worse, with production falling off more and more, old man Goodell getting more crabby, and the old office fossils more cantankerous all the time, until the master mechanic got peeved, came over and blessed out the whole outfit and looked about to see where more steam was needed. First thing he sent over a young woman as clerk in the office. Now, wouldn't that jar you—a woman in this car shop? We sure didn't know what to make of it at first, but that girl, with her smile for everybody and prompt and ready answer to every question we had to ask in the office, soon had us all going her way. First thing, the boys marked a line a hundred yards around the office and let every man on the force know that it would not be good for his health to be heard using bad language inside that circle. Soon the boys got so in the habit of minding their tongues that you hardly ever hear them cuss anywhere now. Only that old fossil in the office gets a fit sometimes when that girl goes to work and changes things about, but that don't worry her any. Now they can put their hands on any record there in a minute, while before they always had to hunt all over to find anything.

"Next thing old man Goodell came down with the 'flu' and died, after a long hard struggle. Our men and their wives went there and did all they could, and Miss Ellen, who seemed not to like their coming at first, later realized what good friends our people were to her, and she has stuck to them ever since. She makes her living now working in an office downtown, since the old man didn't leave her anything, and mighty sad and lonely she looks, too.

"Next comes this here new foreman walking in on us one fine morning, and the old man in the office gives up to a new man who used to be in business and runs the whole office like a business, too. Well, every blessed morning since he came the foreman has found time to go all over the shop yard and give a pleasant 'Good morning' and cheery word to everyone of us, but his eye goes flying around and he sees everything that's going on. If anyone has a request he listens and gives a prompt answer, and I often see him do three things at one and the same time, like talking to the big boss, answering questions for his men, signing papers, all with the same smile, and yet nothing escapes his eye that's going on around the yard. He may not know as much about car repairing as old man Goodell did, but then he'll accept a suggestion from us old-timers anyway and even ask our opinion of how some things should be done. He is on to every man here and how to handle him — to get the most work out of him, which seems to be his pet study.

"See those two Italians over there? They used to be about the slowest team on this ranch. Some time ago they had a heavy repair job on a coal car and didn't make any headway at all with it at first. What do you think he does? Cuss them? Not on your life. He just gives them a little talk on the coal shortage misery every day as he goes by, until those fellows got so interested that they felt they made a lot of poor women and kids up north suffer just so much longer for want of that old car to move coal. First thing they worked like blazes to get rid of the car, and they were proud as peacocks when she rolled out of the yard. That's the way he'll get us all interested in whatever we do; he always has something to tell you that stirs you up somehow. He'll talk about tools or metal or merchandise or anything, and he has those coach workers so interested they lose sleep sometimes thinking over their jobs. He got them impressed by degrees with how much damage a poor job of theirs can do to a crowd of passengers, so they always feel as if they are responsible for the lives of the people that travel in their cars.

"Besides making us look differently at the work we are doing, all the boys are in the habit now of going to him with our personal troubles and there's nothing so small that he won't have a kind word of advice for. If it's anything about our time or some writing to be done, he sends them to his office and the clerks there are always willing and ready to listen and do what they can. The boss never wants to hear anybody say about anything, 'I haven't got time.' You can go to his office with a little scratch on your hand or any kind of hurt and they'll drop everything else and clean and bandage you. But let any fellow try to tell him a tale about some one—he'll make him prove it or eat it, and he'll fight at the drop of a hat if he sees any crooked things going on.

"We did have some underhand agitators around here that tried to stir up a little trouble, but they quit and left the country as soon as the boys caught on to their works. It didn't seem healthy around here for them. Now you know why we all like to come to work here in the morning."

Sidney soon became familiar with the new conditions and worked with a new enthusiasm, seeing his dreams of working conditions coming more true all about him. He received another surprise at the first meeting of their local union

Sidney Simply Picked Her Up and Held Her to His Heart

which he attended. Formerly the men, in their unofficial debates after the business meeting, talked about nothing but grievances, sport, drink and so forth; now the conversation was almost entirely about their work. With wonder he was told that there was a monthly production contest going on between their shop and the nearest one on the system. It was altogether unofficial, but the clerks in both offices were gladly working overtime to supply the data, which were figured out somewhat after the old piecework schedule. Interest in the outcome was intense, resulting in increased production at both shops. The foremen on both sides never interfered, he was told, except to see that only good work left the shops.

Sidney's intelligent and honest work was quickly recognized by the new foreman, who often stopped to talk to him briefly, feeling him out on different topics, until one day he asked Sidney to a social gathering to be held at his home that evening. He explained that this was an altogether informal gathering of men and women interested in their line of work and said that these little socials often gave them all much help by giving them an opportunity to talk over

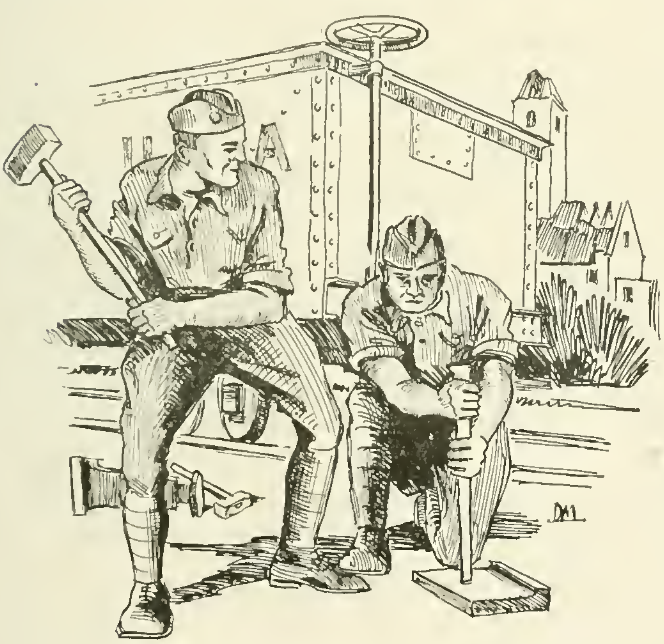
matters that they had not time enough for during working hours.

Sidney welcomed the diversion. Ben's recital of Ellen's troubles had touched him deeply; he loved her still, but was afraid to meet her, not knowing how she would receive him and still yearning to go to her to comfort and protect her.

At the foreman's house he was received like an old friend by Mrs. Woods and her daughter. He found a number of the shopmen and some of their wives, so that he felt quite at home at once.

Still other guests were arriving when Miss Woods asked him to come with her to meet her dearest friend, who was helping to prepare some refreshments for them all. Following her into another room he noticed a young woman with her back turned to him. When he approached she turned about, and then Sidney found himself looking straight into the eyes of Ellen Goodell. His heart jumped at the message those eyes held for him, when Ellen held out both hands to him and in a low voice said, "Sidney, can you forgive me? I have since found out what happiness it gives to serve, and that in service we are all equals."

Stunned by the suddenness of it all, Sidney simply picked



And How this Ever Revived Them and Spurred Them to Renewed Effort

her up and held her to his heart. After an interval of blissful forgetfulness of all his surroundings, he said, "Child, I'll never leave you again, but our squabble was too serious; it can only be patched up by a preacher, and he'll have to act pretty soon at that." To this Ellen readily consented and sealed the agreement with a kiss.

Guiltily looking around, they found themselves all alone in the room. Joining the company again they were greeted with congratulations and laughter.

"Well, said Mr. Woods, "talk about a rapid fire, you two sure get the prize, from the looks on your faces. Here my wife and girl framed this meeting carefully, to get you two together again by degrees, and you take the whole works by storm at the first shot. You must have learned that in the war."

After the pleasant excitement over this happy solution of the lovers' quarrel had subsided, Mr. Woods skillfully led Sidney to recite some of his experiences as car repairer at the front in France. As he warmed up to his subject and his recollection of incidents came back, he became eloquent in his enthusiasm, and the whole assembly was listening in breathless concern to his narrative. He told how many a time they had realized that thousands of lives of their brave boys in the war front had depended on the despatch of a train of munitions or food, and how he and his companions had worked to utter exhaustion to get the damaged rolling stock in condition again. How under gruelling shellfire and unspeakable conditions of filth, mud and hunger, as men standing next to him were blown into eternity; when despair of being able to go on further had turned into abject fear and horror and he had felt ready to lay down right then and give up, their lieutenant, with the eternal cigarette between his smiling lips, would turn up and simply tell them not to forget, that they were only allowed to stay back there in comparative safety and comfort so that they could serve those gallant boys up ahead, who had to get along in a living hell to fulfill their duty, and how this ever revived them and spurred them to renewed effort.

"That was the time," Sidney said, "that I realized fully and forever, that the laborer's real pay is not in his envelope, but in his service to his fellow man."

"There, friends," broke in Mr. Woods, "is the keynote of success for all workers alike. Service to the good of humanity. They say that corporations have no soul, but I say, that from the same point of view the great mass of our unions, supervisory officers and workingmen have the same lack of soul and only when all parties concerned will go out to hunt for and recognize the other fellow's soul, will there be real harmony and better times for all.

"I firmly believe that the American workingman has too active a mind and too broad a conception of life, not eventually to find his way out of all the present misconceptions and troubles, into this line of thought. So let us all hope and put forth our individual efforts in the great task of smoothing the path between employer and employee, with the thought of service to mankind ever before us."

A New Lubricant.—A new fruit containing a large percentage of oil has been discovered in the region of Torreon, Mexico, and is known by the name of chichopoxtle. Experiments show that 25 per cent of its contents consists of oil of great value in industrial pursuits requiring a lubricant of high quality. It is proposed to introduce the cultivation of this fruit on a large scale.—*Railroad Men.*

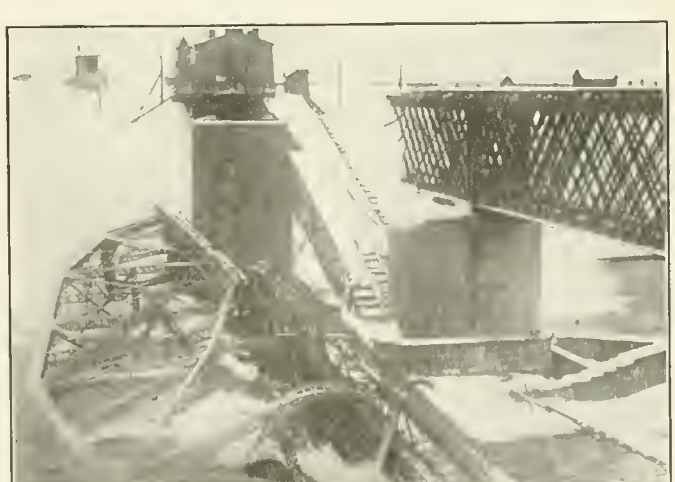


Photo from Underwood & Underwood, N. Y.

Railway Bridge at Narva, Esthonia, Destroyed in Campaigns Against Bolsheviki

Standard Motion Work Aids Valve Setter

Fundamental Valve Gear Dimensions Are Carefully Checked With the Blue Print at West Albany

BY J. McALLISTER
General Foreman, West Albany Shop, New York Central

THE work of setting valves on a heavy repair locomotive is greatly simplified and reduced when the important dimensions of each valve gear part are made to check with the blue print before that part goes to the erecting shop for assembly. This careful checking of dimensions is made necessary by two conditions. First, the builders are not infallible, and occasionally a mistake is found in a practically new locomotive valve gear. For example, the distance between the steam edge of the back port and the center of the link trunnion of a locomotive equipped with a Walschaert gear was recently found to be 5/8 in. longer on one side than on the other.

The second reason for checking dimensions is that valve setters often make slight alterations when squaring a valve, and by the time a locomotive has had three or four general repairs there may be serious differences between the actual valve gear dimensions and those called for by the blue print. As an example of the latter case, the practice of making valve adjustments by upsetting or lengthening the radius bar may be mentioned. This results in a radius bar that does not correspond in length with the link radius and introduces irregularities into the valve motion. Sometimes the distances between pin centers of the combination lever are not in the right proportion, or the lead is not properly equalized by the union link. Perhaps the right-hand valve stem is longer than the left or the valve chamber bushings are too near together.

A valve gear may be completely overhauled and all worn parts renewed, but if the above-mentioned discrepancies are not noted and corrected in the machine shop they will have to be corrected by the valve setter, who does not discover them until all the motion work has been connected up. This involves taking down at least part of the motion work again, and very often results in a delay to the locomotive. Obviously the best way is to check all motion work carefully in the machine shop and, as far as possible, make it correspond exactly with the blue print.

Method of Handling Motion Work

While it is not claimed that any new method of setting valves has been developed at West Albany, the following system of handling motion work through the shops has made valve setting a comparatively simple operation which requires only a minimum of time.

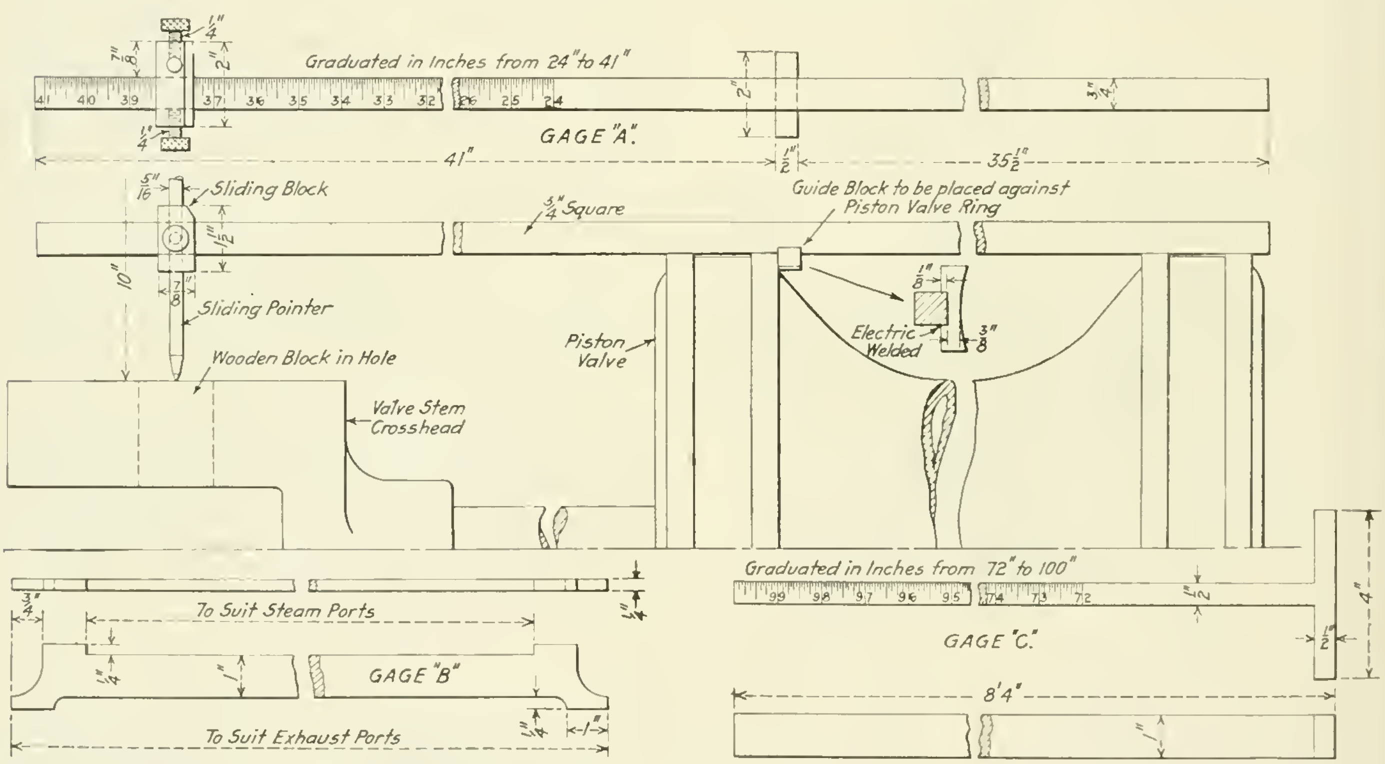
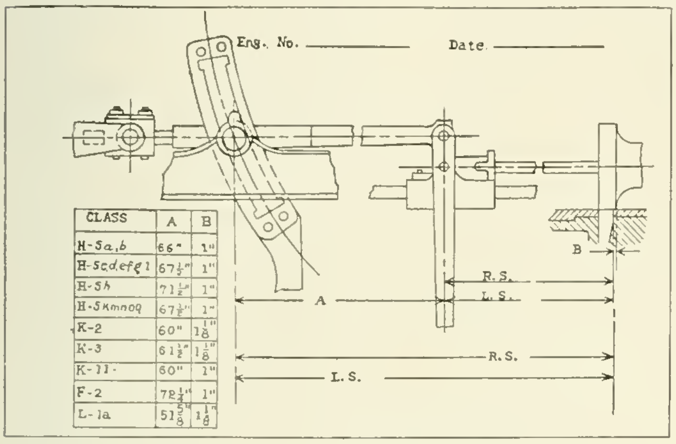


Fig. 1. Gages Used in Checking Valve Gear Dimensions at the West Albany Shops

All locomotives shopped for classified repairs have the valves and motion work removed and sent to the machine shop. Exact measurements are taken with gage *C*, Fig. 1, of the distance from the steam edge of the back port to the center of the link trunnion on each side of the locomotive. This distance is marked on valve setting Form No. 1, which is then delivered to the machine shop foreman. The valve chamber bushings are calipered and gaged, using gage *B*. The bushings must gage properly, and if they do not, new ones are applied and bored out. If found to be out of round and not below the limit of thickness, the bushings are bored.

All parts of the motion work are dismantled and new hardened bushings and pins are applied where necessary. All worn parts are built up by autogenous welding and

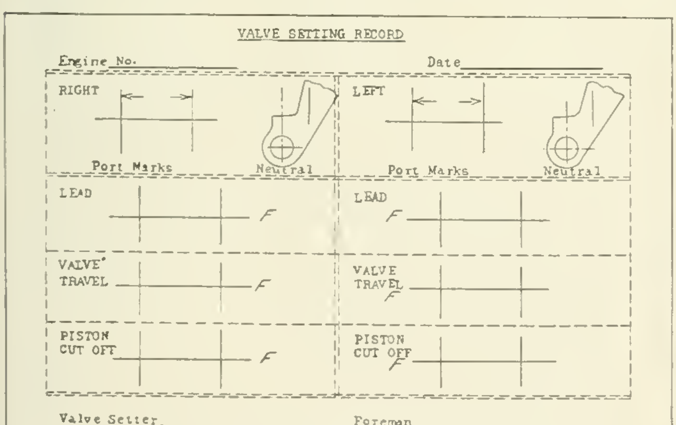
machined to the standard size. The radius bars are trammed for length, using standard stationary trammels made to conform to the true radius of the links. If not of the proper length, the radius bars are sent to the blacksmith shop for correction. The combination levers are lined up on a surface table and measured for the proper distances between pin centers. If they are found not according to the blue print, corrections are made. The links are ground to the proper radius. The link blocks are built up by autogenous welding and refitted. Trunnion plates are applied, the holes



Valve Setting Form No. 1

being reamed and new bolts fitted. If the trunnion centers do not check with the link centers, new trunnion centers are turned and bushings applied.

The valves are dismantled, the valve stems are ground or renewed as necessary and fitted to the valve crosshead. New packing rings are properly fitted to the bushings. The valves are then assembled and measurements taken from the center of the combination lever pin hole in the valve crosshead to the edge of the back steam ring, using gage A. This distance, plus the length of the radius bar, must equal the meas-



Valve Setting Form No. 2

urements marked on Form No. 1, plus the lap of the valve. Parts are delivered to the erecting floors ready for assembling.

Method of Setting Valves

The motion work is assembled on the locomotive, the valves put in and port marks scratched on the valve stems. The reverse lever is placed in the central position and the link blocks lined up or down to get a dead valve on both sides. The combination lever is plumbed. If the work has been done properly the valves will be neutral. The union links are connected up, the locomotives placed on centers and the lead marked on the valve stems. If the lead is not properly equalized, alterations are made in the union link.

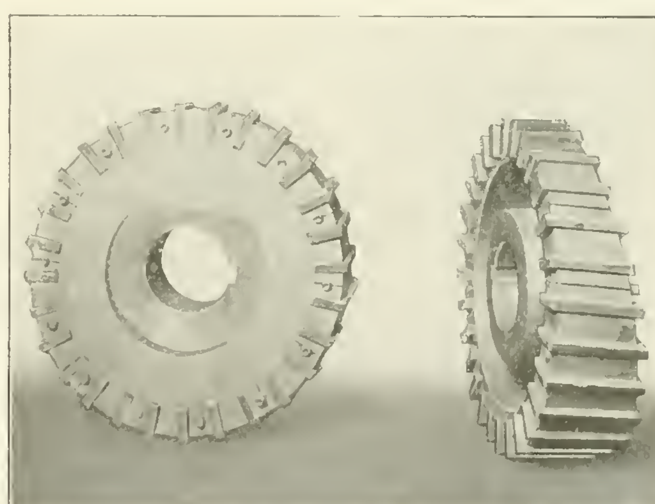
The locomotive is now placed on the centers in full gear forward and back. The eccentric crank is trammed for the neutral position, the lead marked aand adjustments made in the eccentric rod if necessary. The engine is run over, with the reverse lever hooked up to adjust the cut-off to 25 per cent for passenger locomotives and 30 per cent for freight locomotives. The lead, valve travel and piston cut-off are taken in both forward and back motion. Adjustments are made to equalize the piston cut-off, a greater variation than one-half inch not being permitted. The necessary offsets for crank arm keys is measured.

Before removing the crank arms to apply the rods, they must be gaged with the usual form of crank gage supplied for that purpose and readings taken. When reapplied and permanently keyed, the crank arms must check with the readings. Valve setting Forms No. 1 and No. 2, after being filled out, are kept as a permanent record.

As previously indicated, the above method of making motion work repairs and setting valves has worked out well, and the results have amply repaid all additional care and attention given this matter. Locomotives are no longer delayed by mistakes in the valve gear discovered at the last minute; no time is wasted "squaring values" after the locomotive has had a trial run; a good valve gear is assured, which sounds square, has an equalized cut-off and gives a good distribution of steam.

ADJUSTABLE MILLING CUTTERS

There are many places where milling cutters which are adjustable in width can be used to advantage. The ordinary types of adjustable cutters, however, are not satisfactory because the width can only be adjusted slightly less than twice the overhang of the blade. An interesting design of adjustable cutters in use at the Dale street shop of the Great Northern is shown in the illustration below. The cutters are used in pairs. The body of each has one side perpendicular to



Milling Cutters With a Wide Range of Adjustment

the axis, while the other side is cut out at a small angle to it. The key ways are located so that when placed on the arbor the narrow part of one cutter is adjacent to the wide side of the other. By placing rings between the two parts, the width of the cut can be varied by an amount equal to the difference between the length of the longest and the shortest blade. As the total length of the cutters which are in operation remains the same at all times, there is no change in the torque on the arbor and no tendency to chatter. This arrangement has been found useful for cutting out shoes and wedges, crosshead shoes and similar parts.

Railroads Fail Badly In Training Shopmen

Mechanical Department of Railroad Administration Compiles Statistics as to Number of Apprentices

ALMOST fifteen years ago George M. Basford, then editor of the American Engineer and Railroad Journal, made his memorable address before the American Railway Master Mechanics' Association, in which he pointed out the vital necessity on the part of the railroads of giving immediate attention to the selection, preparation and training of men for railroad service. The American Engineer and Railroad Journal and its successor, the *Railway Mechanical Engineer,* have consistently emphasized Mr. Basford's recommendations, in season and out of season, for all these years.

What has been the net result, so far as the mechanical departments of our railroads are concerned? We are ashamed to have to admit that very little has been accomplished. Whether it be because Mr. Basford was too far ahead of his time, whether because of lack of ability on the part of Mr. Basford's followers and the technical press in presenting the matter to the railroads, whether it be a lack of vision and executive ability on the part of the railroad managers, or whether it be a combination of all of these things, the results in the railroad field have been truly disappointing. Men in other industries have been quicker to adopt Mr. Basford's suggestions and, directly or indirectly, his suggestions have had a big influence on the development of the National Association of Corporation Schools and the speeding up of apprentice training in the industrial field.

No one has accused the mechanical department of the Railroad Administration of being wildly enthusiastic about the extension of apprentice training. Why should it be? If when the Railroad Administration took over the control of the railroads it had had behind it 10 or 12 years of real apprentice training its task would have been much easier. The railroads had never given the matter any serious attention (except in a few isolated spots); why should it do so? Moreover, the most ardent advocates of the proper selection, preparation and training of employees are not foolish enough to promise immediate results—and immediate results were what the Railroad Administration had to have.

In spite of this, however, Mr. McManamy has compiled complete data as to the number of workmen, helpers and apprentices in each craft on all the roads under federol control. This data is given in full in the accompanying tables. It does not give us any particular pleasure to publish it. We dislike to have to show up a condition which, to say the least, does not reflect any credit upon the railroad mechanical departments of the United States. We pride ourselves on leading the world with our wonderful railroads and our efficient methods. It is too bad that we do not compare more favorably with foreign roads when it comes to the selection, preparation and training of employees. It is strange that we have so little appreciation of the importance of the human factor in our railroad operations.

The figures as to the number of apprentices of course tell only part of the story, bad as it is. If as concrete a picture could be presented of the methods of instruction of apprentices on the different roads, the shock would be still greater. A few—a very few—roads have gone at the problem in a big way, but the great majority have just played with the task and have hardly touched the edges of the job.

Organized labor has the reputation of keeping down the percentage of apprentices. Has it? It seems more than passing strange that those sections of the country where shop labor was so highly organized in pre-war days should show up so well in comparison with other sections. It surely looks as if the railroad shop managements should be held to their accountability in restricting the number of apprentices. If the figures as to machinist apprentices do not bother you, run your eyes along the line to the other crafts. Do not hurriedly jump over the carmen.

But why comment further? The figures tell the dismal story plainly enough. If the Interstate Commerce Commission or some other governmental agency should step in and take a hand in the matter by ordering improvements to be made there would be an awful howl—but what are the railroads doing to make good?

In June, 1905, Mr. Basford closed his address with these words: "Are we a nation so enveloped in a cloak of progress that we cannot see the future?" Since 1905 hundreds of our big industrial companies have met this challenge by inaugurating modern up-to-date methods for training their men. Ought we not today ask this question: "Are the railroads of the United States so sound asleep as to the importance of training and developing the human factor that they will fail to make good in the future?"

* * *

Assume for a moment that the railroads generally did awaken to their full responsibilities and really did inaugurate modern up-to-date apprentice systems, would that be sufficient? No! To make these measures fully effective—and we, of course, assume that they would be accompanied by steps to insure the proper selection of boys and young men—it will be necessary to take measures to study critically the disposition, ability and performance of each individual in the organization so that the men may be assigned to those tasks for which they are best fitted and in order that promotions may be made intelligently and in the best interests of the organization as a whole.

We subject the most ordinary materials that we use on railroads to all sorts of tests, even resorting to the compound microscope and to micro-photographs. But what about the most vital factor in railroad or industrial organization—the human factor? Why is John Smith assigned to lathe work? Is it because he is better fitted for that particular work than for other tasks, or is it purely accidental? Why was Bill Jones made gang boss or foreman? Is it because he had been subjected to critical study over an extended period, or is it because he happened to be in favor, or particularly prominent, at the time the appointment was made?

If the wrong man is promoted how much damage is done? In the ranks Bill Jones was an individual. As a foreman his inefficiency may be multiplied by the number of men under his direction. Moreover, other men, realizing that he is a misfit, feel that merit is not recognized and lose any ambition to strive to so perfect themselves as to be available for promotion. They reason that the chances of being hit by promotion by "the hit and miss" method of selection are about the same as being hit by lightning. Because promotions are not made by scientific, accurate means and because no standards of measurement are set, they lose interest or, if they do believe in lightning rods, take such peculiar measures as they think will give the best results in attracting the attention of that peculiar and uncertain element.

It is too bad, for the solution of these difficulties is so simple and easy, and so well worth while, if we would only awaken to the seriousness of the situation.

TABLE I—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS. EASTERN REGION.

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	Grand Totals
Ann Arbor	39	22	8	17	15	1	8	9	1	2	1	..	9	..	..	60	6	..	..	..	..	48	10	..	256
Bangor & Aroostook	70	48	7	17	15	..	13	11	..	4	2	1	3	1	1	198	11	..	1	..	..	..	..	..	403
Boston & Albany	367	221	54	77	100	14	56	52	4	21	10	6	121	49	..	421	208	11	..	..	..	200	723	94	2,809
Boston & Maine	1,015	679	93	255	268	6	165	175	4	108	52	..	78	19	1	2,170	132	21	..	..	..	350	242	..	5,833
Buffalo, Rochester & Pittsburgh	324	225	65	120	55	7	46	38	2	61	16	3	77	34	..	724	70	4	1	..	..	..	..	..	1,872
Central New England	47	42	..	18	15	..	7	8	..	3	2	..	4	..	..	218	3	..	..	..	..	111	19	..	477
Central Vermont	166	43	18	55	30	9	23	10	3	13	2	2	8	..	..	198	10	2	10	3	1	52	..	..	658
Chicago & Erie	141	98	35	67	38	12	21	17	3	29	12	4	34	21	..	380	38	..	..	..	..	..	..	..	950
Chicago, Ind. & Louisville	175	124	28	76	104	15	25	29	..	28	14	4	11	5	..	350	45	..	1	2	..	37	8	..	1,081
Cincinnati, Ind. & Western	69	57	13	42	41	4	11	15	2	10	9	2	12	8	..	136	26	11	2	..	..	7	21	..	498
Cincinnati Northern	34	39	5	26	22	..	6	8	..	7	2	..	3	..	..	72	19	1	..	..	..	5	..	..	249
C., C., C. & St. Louis	779	455	140	261	174	24	154	164	11	105	46	11	334	78	4	2,415	176	54	..	..	..	30	..	..	5,415
Delaware & Hudson	762	444	101	210	129	24	102	102	1	62	28	2	137	17	4	1,608	98	17	36	3	..	231	39	1	4,160
Delaware, Lack. & Western	913	588	162	273	211	36	132	136	11	232	86	4	270	128	5	1,805	218	12	71	12	8	314	145	1	5,773
Detroit & Mackinac	23	16	5	5	7	1	7	6	..	3	..	..	..	..	..	55	..	..	..	..	..	14	4	..	146
Detroit & Toledo Shore Line	10	8	1	6	4	1	2	1	..	1.	1	..	..	..	..	32	3	..	..	..	..	14	..	..	84
Erie	1,844	1,329	326	576	323	70	252	241	15	392	138	16	367	226	13	2,941	442	16	31	..	4	86	7	..	9,655
Grand Trunk Western	353	150	58	72	65	9	88	62	2	84	22	1	137	26	15	1.172	56	4	2	..	..	760	..	..	3,138
Detroit, Toledo & Ironton	55	23	18	25	24	1	11	11	..	9	1	..	10	1	..	144	21	..	..	..	..	27	2	1	384
Grand Trunk in New England	54	38	26	10	16	..	10	12	..	7	..	..	9	5	..	80	1	23	2	1	..	83	33	2	412
Hocking Valley	162	108	21	66	66	9	33	39	1	53	28	3	18	1	1	582	70	2	4	4	..	98	32	..	1,401
Kanawha & Michigan	48	38	8	22	24	2	13	17	..	5	3	1	2	1	..	228	84	..	1	..	..	40	6	1	544
Lake Erie & Western	104	113	20	59	65	5	19	24	2	13	4	..	48	37	..	219	27	..	2	1	..	192	23	3	980
Lehigh & Hudson River	32	29	20	7	12	6	5	5	1	2	1	..	9	5	..	58	3	..	..	..	..	4	1	..	202
Lehigh & New England	73	30	12	16	23	1	6	6	..	9	4	1	12	4	..	64	1	3	..	..	..	17	29	..	311
Lehigh Valley	1,208	687	174	346	236	26	148	171	11	171	76	7	364	99	10	2,042	279	21	2	1	..	357	85	..	6,521
Maine Central	230	144	15	53	53	..	45	47	..	23	5	..	51	40	..	926	82	3	..	..	..	9	2	..	1,728
Michigan Central	676	364	85	233	187	7	124	93	2	99	50	..	225	94	2	2,350	247	..	3	2	..	290	315	2	5,450
Monongahela	17	16	..	8	7	..	1	1	..	..	..	..	2	1	..	88	..	..	..	..	..	..	..	8	149
New York Central	2,784	1,803	357	1,082	790	40	495	497	13	660	270	19	1,349	335	127	10,544	1,215	60	72	85	2	1,068	411	1	24,079
New York, Chicago & St. Louis	194	133	32	88	96	8	29	38	..	13	9	1	19	..	..	656	53	..	2	1	..	369	63	..	1,794
New York, New Haven & Hartford	1,282	944	141	292	284	24	163	191	4	273	169	2	422	183	22	2,301	249	11	..	..	..	1,105	266	7	8,335
New York, Ontario & Western	161	132	24	45	45	4	29	35	..	16	3	..	57	16	..	385	81	13	..	..	..	31	12	..	1,089
New York, Susquehanna & Western	71	24	14	18	8	2	10	4	..	9	2	..	15	3	..	58	8	..	..	..	..	..	..	..	246
Pere Marquette	448	251	77	205	158	7	59	75	1	69	33	..	71	10	1	907	202	8	..	..	..	658	13	..	3,253
Pittsburgh & Lake Erie	317	266	52	77	70	..	39	37	..	53	12	..	138	23	..	1,792	247	..	..	..	..	63	256	..	3,442
Pittsburgh & Shawmut	33	17	..	7	6	..	4	3	..	2	..	..	1	..	..	24	1	..	..	..	..	..	..	..	98
Pittsburgh & West Virginia	37	27	3	13	13	4	6	7	1	..	..	..	10	3	..	97	..	..	..	..	..	18	1	..	240
Rutland	66	61	10	16	14	..	11	14	..	8	3	1	3	1	1	173	13	2	1	1	..	59	..	..	458
Toledo & Ohio Central	152	110	21	77	45	1	26	20	..	21	4	1	48	14	..	416	59	4	..	..	..	4	..	..	1,023
Toledo, St. Louis & Western	66	87	32	34	51	4	14	21	..	16	2	..	8	2	1	216	102	1	1	5	1	92	32	..	788
Ulster & Delaware	14	7	8	6	2	4	2	2	..	1	..	..	7	1	..	23	2	1	..	..	..	2	9	..	91
Wabash	687	554	97	200	226	25	117	145	11	148	79	25	74	9	3	1,260	223	8	5	2	..	..	..	..	3,898
Wheeling & Lake Erie	200	95	35	72	101	8	27	36	1	28	3	5	32	3	..	518	132	1	4	..	..	113	56	1	1,471
	16,302	10,635	2,421	5,250	4,238	421	2,564	2,635	107	2,873	1,204	122	4,609	1,505	211	41,106	4,965	314	254	123	16	6,948	2,865	122	111,864
Ratio	....	1.5	6.7	....	1.2	12.4	....	.9	24.0	....	2.4	23.5	....	3.0	21.8	....	8.2	130.8	....	2.0	15.9	....	2.4	56.9	......

TABLE II—MECHANICS, HELPERS, AND APPRENTICES IN ALL DEPARTMENTS BY CRAFTS. ALLEGHENY REGION.

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	Grand Totals
Atlantic City	22	11	1	7	5	..	4	2	..	1	..	..	6	6	..	50	..	..	..	..	..	30	4	..	149
Baltimore, Chesapeake & Atlantic	5	6	..	3	4	..	1	1	..	..	..	..	1	..	..	..	..	..	..	..	..	3	..	..	24
Baltimore & Ohio Lines, West	1,214	889	177	516	571	54	168	196	7	232	107	26	143	56	3	2,583	223	12	27	35	2	465	95	3	7,804
Baltimore & Ohio Lines, East	1,795	1,242	274	631	554	17	230	220	4	320	188	7	294	130	110	3,793	600	12	49	64	1	2,852	274	4	13,165
Bessemer & Lake Erie	227	174	2	66	50	..	29	25	..	17	6	..	31	5	..	649	49	..	2	1	..	1	..	..	1,334
Buffalo & Susquehanna	39	23	7	13	10	3	8	12	2	4	3	1	..	..	..	108	65	5	1	1	..	..	..	..	305
Central Railroad of New Jersey	614	435	82	204	179	14	87	122	2	96	64	..	168	41	9	1,649	461	10	..	..	..	294	23	..	4,289

TABLE II MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS ALLEGHENY REGION *Continued*

	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			
Railroad	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	Grand Totals
Coal & Coke	21	24	5	7	10	2	7	6	..	5	3	..	6	..	..	82	9	..	..	..	..	4	..	..	191
Grand Rapids & Indiana	128	28	15	29	21	4	15	16	..	30	2	..	13	2	1	230	33	4	1	1	..	..	23	..	596
Hudson & Manhattan	62	29	1	8	7	..	6	6	..	11	1	..	153	21	1	99	52	..	..	..	..	4	..	..	461
Long Island	198	152	13	61	48	4	25	36	..	136	70	3	235	145	28	323	99	2	..	..	..	231	40	..	1,849
Maryland, Delaware & Virginia	2	8	1	2	3	..	1	1	..	..	..	..	1	..	..	3	2	..	..	..	..	..	..	..	24
New York, Philadelphia & Norfolk	36	25	8	9	11	..	4	5	..	10	10	..	20	13	..	44	14	..	..	..	..	47	8	..	264
Pennsylvania R. R. Lines, West	1,856	1,110	163	581	434	33	261	271	3	391	154	18	562	95	14	3,911	368	15	27	22	..	76	18	..	10,388
Pennsylvania R. R. Lines, East	10,547	4,356	771	2,253	914	39	1,412	1,446	30	1,813	454	21	2,829	468	47	14,820	3,225	35	296	164	6	1,773	349	9	48,077
Philadelphia & Reading	1,182	693	430	430	241	6	214	212	..	197	96	..	326	103	6	2,563	388	5	79	45	..	9	9	..	6,868
P., C., C. & St. Louis	2,594	1,102	194	680	339	29	360	357	9	364	147	15	352	39	3	4,199	350	12	12	5	1	671	128	..	11,962
Port Reading Railroad	5	2	..	4	3	..	2	2	..	..	..	..	4	..	..	38	2	..	..	..	..	..	..	..	62
Staten Island Rapid Transit	89	46	..	23	11	..	8	6	..	6	3	..	14	6	..	65	2	..	..	..	..	95	9	..	383
Western Maryland	337	203	100	94	80	16	41	58	8	57	43	4	27	9	1	749	27	4	1	..	..	675	10	..	2,544
West Jersey & Seashore	22	18	5	18	13	1	8	2	1	14	2	..	151	21	5	51	11	3	..	..	..	44	19	..	409
	20,995	10,576	1,183	5,639	3,508	227	2,891	3,002	66	3,704	1,353	95	5,336	1,160	228	36,009	5,980	119	495	338	10	6,774	1,009	16	111,413
Ratio	....	1.9	11.0	....	1.6	25.2	....	.9	43.8	....	2.7	38.9	....	4.6	23.4	....	6.0	303.0	....	1.4	49.5	....	6.7	423.3	......

TABLE III MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS POCAHONTAS REGION.

	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			
Railroad	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	Grand Totals
Chesapeake & Ohio	859	528	168	254	276	53	165	245	13	142	73	31	280	45	9	2,571	535	109	6	18	1	201	174	..	6,756
Norfolk & Western	1,355	726	241	265	177	38	179	198	11	242	102	43	291	107	23	4,110	380	16	56	136	13	..	..	..	8,709
Virginian	129	119	28	34	34	7	25	26	1	30	18	6	16	2	1	306	14	9	..	..	..	323	..	..	1,128
	2,343	1,373	437	553	487	98	369	469	25	414	193	80	587	154	33	6,987	929	134	62	154	14	524	174	..	16,593
Ratio	....	1.7	5.3	....	1.1	5.6	....	.8	14.7	....	2.1	5.2	....	3.8	17.7	....	7.5	52.0	....	.4	4.4	....	3.0	....	......

TABLE IV MECHANICS, HELPERS, AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS. SOUTHERN REGION.

	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			
Railroad	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	Grand Totals
Alabama & Vicksburg	5	6	..	2	4	..	1	1	..	..	..	..	7	..	..	23	..	..	..	..	..	..	..	..	49
Alabama Great Southern	92	52	18	25	22	4	18	24	2	12	14	2	22	3	1	154	36	3	..	..	..	..	..	..	504
Atlanta & West Point	35	20	4	6	10	2	6	10	..	12	8	1	4	1	..	73	14	2	..	..	..	16	4	..	228
Atlanta, Birmingham & Atlantic	39	42	7	11	17	2	6	12	3	6	11	4	2	1	..	121	35	12	..	..	..	16	4	1	352
Atlantic Coast Line	543	412	109	188	255	40	108	183	23	99	91	25	93	47	10	1,670	251	73	18	15	5	207	56	1	4,522
Carolina, Clinchfield & Ohio	62	29	19	13	11	4	7	15	1	8	2	5	6	1	..	146	15	13	1	3	..	..	..	..	361
Central of Georgia	192	104	43	51	70	11	37	63	9	44	17	10	27	7	2	427	217	67	1	1	..	45	..	..	1,445
Charleston & Western Carolina	30	19	6	9	13	2	9	8	1	4	4	2	2	1	..	52	10	2	..	..	..	6	10	..	190
Cin., N. O. & Texas Pacific	245	186	55	59	54	9	48	56	3	41	35	9	68	13	6	600	34	27	4	3	1	..	..	..	1,556
Florida East Coast	63	60	10	18	25	5	14	17	1	15	9	1	20	1	1	226	37	2	2	2	..	27	..	1	557
Georgia Railroad	40	28	4	80	17	3	9	18	1	7	4	4	2	..	..	113	16	9	..	..	..	25	4	..	384
Georgia Southern & Florida	43	32	8	13	19	3	9	12	1	6	6	..	3	..	1	121	19	10	..	..	..	..	..	..	306
Gulf & Ship Island	20	11	14	5	9	2	6	7	..	3	1	1	..	..	..	97	14	1	..	..	..	5	1	..	197
Gulf, Mobile & Northern	34	24	8	6	9	3	7	11	1	4	2	2	..	..	..	69	13	3	..	..	..	20	6	..	222
Illinois Central	1,638	1,054	520	612	626	80	244	321	19	326	69	51	376	183	..	5,472	502	65	18	10	6	118	503	..	12,813
Louisville & Nashville	1,300	918	235	489	545	37	253	331	3	240	141	18	116	12	7	4,811	434	114	86	99	..	5,720	..	..	15,909
Louisville, Henderson & St. Louis	11	7	2	4	3	1	2	1	1	2	..	1	2	..	1	34	1	2	..	..	..	2	..	1	78
Mississippi Central	10	4	3	2	4	1	3	5	1	1	..	..	1	..	1	16	..	..	..	..	..	28	4	..	84
Mobile & Ohio	220	180	38	65	75	14	34	52	7	25	24	5	10	3	1	723	104	75	9	8	..	146	10	..	1,828
Nashville, Chattanooga & St. Louis	220	178	19	66	46	..	33	50	..	45	22	..	79	13	..	810	121	4	23	10	1	..	..	..	1,740
New Orleans & Northeastern	92	63	20	26	42	4	28	43	4	17	12	3	17	3	2	525	19	1	1	1	..	..	..	..	923
New Orleans Great Northern	26	23	6	4	10	1	4	5	..	4	2	..	1	1	..	68	13	50	..	..	..	1	..	..	219
Norfolk Southern	45	36	7	13	15	4	13	15	2	11	8	1	5	5	2	159	28	..	..	..	..	25	..	..	394
R. F. & Potomac	95	45	18	26	26	2	21	27	2	20	17	3	23	7	..	207	9	..	1	..	..	35	24	..	608
Seaboard Air Line	355	244	76	88	23	118	56	100	11	57	63	15	35	10	4	705	46	..	10	26	1	345	98	3	2,489
Southern	1,133	933	216	328	393	66	181	256	29	183	146	44	138	37	35	3,553	314	136	39	8	6	133	..	..	8,307
Southern in Mississippi	15	13	3	4	5	1	2	4	1	1	1	1	..	..	..	42	2	3	..	..	..	6	5	..	109
Tennessee Central	25	23	6	8	9	2	6	9	1	7	4	1	1	1	..	89	8	..	..	..	..	..	..	..	200
Washington Southern	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	....	..	..	..	..	..	..	..	..	12
	6,628	4,746	1,474	2,221	2,357	421	1,165	1,656	127	1,200	713	209	1,072	350	74	21,106	2,312	674	213	186	20	6,926	729	7	56,586
Ratio	....	1.4	4.5	....	.9	5.2	....	.7	9.1	....	1.4	5.7	....	3.0	14.5	....	9.1	31.3	....	1.1	10.0	....	9.5	989.4	......

TABLE V—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—NORTHWESTERN REGION

Railroad	Machinists			Boilermakers			Blacksmiths			Sheet Metal Workers			Electrical Workers			Carmen			Moulders			Other Mechanics			Grand Totals
	Machinists	Helpers	Apprentices	Boilermakers	Helpers	Apprentices	Blacksmiths	Helpers	Apprentices	Sheet Metal Workers	Helpers	Apprentices	Electrical Workers	Helpers	Apprentices	Carmen	Helpers	Apprentices	Moulders	Helpers	Apprentices	Other Mechanics	Helpers	Apprentices	
Chicago & North Western	1,145	947	212	525	529	64	227	285	15	350	132	22	367	117	149	4,686	482	13	23	35	..	802	18	..	11,446
Chicago Great Western	308	153	42	109	59	6	42	51	5	39	16	..	105	35	3	682	52	4	18	9	..	66	7	..	1,811
Chicago, Milwaukee & St. Paul	2,074	1,758	283	727	636	46	552	852	23	328	186	5	359	64	45	4,996	247	2	98	5	..	981	254	1	14,552
Chicago, St. Paul, Minn. & Omaha	308	125	47	139	123	10	65	74	4	52	10	10	37	1	12	912	41	10	3	2	..	40	..	1	2,026
Duluth & Iron Range	62	55	12	23	29	5	15	19	1	10	5	1	9	4	1	145	14	..	3	1	..	22	..	..	436
Duluth, Missabe & Northern	78	94	16	18	38	4	15	16	..	15	17	4	34	9	4	140	27	..	..	..	..	16	..	..	545
Duluth, South Shore & Atlantic	40	29	16	18	19	3	10	12	1	4	..	2	2	..	..	150	18	1	1	..	1	..	..	..	327
Elgin, Joliet & Eastern	159	126	22	73	79	7	44	57	20	29	19	1	42	3	1	1,333	162	15	..	..	..	..	..	..	2,172
Great Northern	1,025	682	218	367	356	22	194	216	4	188	103	16	85	20	2	4,172	173	4	10	..	..	1,255	331	6	9,449
Minneapolis & St. Louis	161	91	26	75	63	6	30	33	..	28	12	..	8	2	..	565	27	21	2	1	..	27	1	..	1,179
Minneapolis, St. Paul & S. Ste. Marie	396	250	63	131	127	8	74	66	3	72	19	2	88	15	1	1,726	80	8	9	6	..	44	..	..	3,208
Mineral Range	9	9	6	3	7	3	5	5	2	1	1	..	..	..	..	33	..	..	..	..	..	..	..	..	84
Minnesota & International	15	11	3	2	1	1	1	1	..	1	..	..	2	5	..	7	..	..	..	..	..	3	8	..	61
Northern Pacific	789	463	168	267	362	44	150	217	6	37	12	10	158	..	8	3,223	16	1	..	..	..	589	76	..	6,596
Oregon-Washington R. R. & Nav.	245	177	26	88	112	4	42	36	1	30	11	..	82	4	..	532	52	..	14	5	..	237	..	..	1,698
Southern Pacific (N. of A.)	151	87	21	31	35	4	38	14	..	7	1	..	79	4	..	256	35	..	..	..	..	..	..	..	763
Spokane, Portland & S.	49	24	7	17	16	2	10	6	1	9	5	..	20	2	..	85	36	..	..	..	..	168	..	..	457
	7,315	5,081	1,188	2,613	2,591	239	1,514	1,980	66	1,200	549	73	1,477	285	226	23,643	1,462	79	181	64	1	4,250	695	8	56,810
Ratio	....	1.4	6.1	....	1.08	10.9	....	.7	22.9	....	2.3	16.4	....	5.2	6.5	....	16.2	299.2	....	2.8	181.0	....	6.1	531.2	......

TABLE VI—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—CENTRAL-WESTERN REGION.

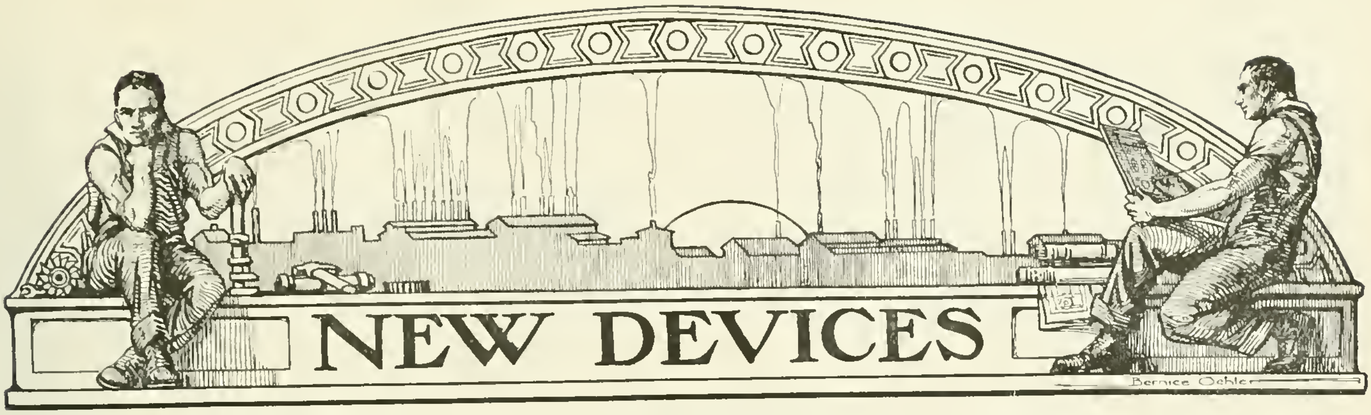
Arizona Eastern	32	17	10	16	19	2	4	8	..	9	7	1	4	..	..	39	3	..	..	..	..	9	6	..	186
Atchison, Topeka & Santa Fe	2,755	1,470	834	872	623	225	345	288	10	479	193	47	448	74	9	5,116	527	38	..	..	..	433	3	..	14,789
Chicago & Alton	369	279	79	139	123	20	52	89	8	61	50	10	76	35	2	884	136	13	22	17	3	19	11	..	2,497
Chicago & Eastern Illinois	327	322	35	120	195	20	64	106	5	70	45	9	54	12	5	1,483	199	13	1	1	..	124	..	..	3,210
Chicago, Burlington & Quincy	1,774	1,111	334	688	585	54	260	326	5	459	141	24	172	20	6	4,994	689	31	34	9	1	336	62	..	12,115
Chicago Peoria & St. Louis	41	33	5	22	24	3	7	11	..	4	2	..	1	..	..	62	4	..	..	..	..	1	..	..	220
Chicago, Rock Island & Pacific	1,405	1,036	205	542	530	78	176	267	28	396	218	28	228	59	25	4,022	473	48	..	..	..	..	..	..	9,764
Chicago, Terre Haute & S. E.	72	36	15	23	25	6	6	7	..	1	..	1	2	..	..	257	19	5	..	..	..	14	4	..	493
Colorado & Southern	156	126	24	52	46	11	19	27	22	22	10	4	10	..	..	182	21	4	..	..	..	41	20	..	797
Denver & Rio Grande	502	231	93	146	131	27	66	103	9	98	58	12	24	8	2	1,198	56	6	2	2	1	..	..	..	2,775
Denver & Salt Lake	62	56	15	19	24	1	13	24	1	13	7	1	1	..	..	110	11	2	..	..	..	42	31	..	433
El Paso & Southwestern	124	80	68	48	55	4	19	25	2	24	12	5	5	..	..	289	23	3	..	..	..	..	..	..	713
Fort Worth & Denver City	92	68	19	37	46	8	13	18	2	2	..	..	..	2	1	248	..	2	..	..	..	55	18	4	635
Los Angeles & Salt Lake	197	167	36	98	106	5	27	41	..	46	23	4	41	6	..	276	38	4	..	..	..	..	..	..	1,115
Northwestern Pacific	38	29	16	9	12	..	7	8	..	10	5	2	26	2	1	88	13	3	1	..	1	..	..	..	271
Oregon Short Line	337	202	55	117	106	6	38	25	2	86	8	3	89	10	14	877	53	3	17	6	4	16	..	..	2,074
St. Joseph & Grand Island	51	34	12	24	21	4	12	9	..	6	3	..	2	..	..	172	3	..	..	..	..	1	1	..	355
Southern Pacific (S. of A.)	664	470	227	222	325	24	126	162	12	160	55	30	113	15	13	1,533	375	70	2	4	..	209	181	..	4,992
Toledo, Peoria & Western	18	3	..	5	3	1	2	2	..	2	..	..	1	..	..	16	..	..	..	..	..	1	..	..	54
Union Pacific	932	811	177	315	360	19	124	167	2	333	174	12	356	68	22	2,481	299	31	2	..	..	28	..	..	6,713
Western Pacific	92	98	37	44	48	9	16	23	3	9	11	3	5	..	..	289	23	3	..	..	.	..	..	..	713
	10,040	6,679	2,296	3,558	3,407	527	1,396	1,736	111	2,890	1,230	196	1,676	313	100	24,622	3,003	292	81	39	10	1,342	346	4	65,086
Ratio	....	1.5	4.3	....	1.04	6.7	....	.7	12.6	....	1.04	11.6	....	5.3	16.7	....	7.5	84.3	....	2.07	8.1	....	3.8	335.5	......

TABLE VII—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—SOUTHWESTERN REGION

Railroad	Machinists: Machinists	Machinists: Helpers	Machinists: Apprentices	Boilermakers: Boilermakers	Boilermakers: Helpers	Boilermakers: Apprentices	Blacksmiths: Blacksmiths	Blacksmiths: Helpers	Blacksmiths: Apprentices	Sheet Metal Workers: Sheet Metal Workers	Sheet Metal Workers: Helpers	Sheet Metal Workers: Apprentices	Electrical Workers: Electrical Workers	Electrical Workers: Helpers	Electrical Workers: Apprentices	Carmen: Carmen	Carmen: Helpers	Carmen: Apprentices	Moulders: Moulders	Moulders: Helpers	Moulders: Apprentices	Other Mechanics: Other Mechanics	Other Mechanics: Helpers	Other Mechanics: Apprentices	Grand Totals
Fort Worth & Rio Grande	11	12	..	4	5	..	2	2	..	2	2	..	..	..	..	29	..	..	..	..	..	6	..	..	75
Gulf Coast Lines	71	77	16	20	28	4	18	31	2	18	15	4	1	..	1	251	73	9	..	..	..	226	57	..	922
Gulf, Colorado & Santa Fe	202	99	97	93	66	19	20	31	3	20	3	8	43	9	7	453	60	57	..	..	..	..	..	..	1,290
International & Great Northern	187	148	32	101	146	20	42	76	3	46	42	8	7	1	1	499	27	25	..	..	..	50	7	1	1,469
Kansas City, Mexico & Orient	54	41	9	37	37	5	5	8	1	8	3	1	1	..	..	120	..	3	..	..	..	11	..	..	344
Kansas City Southern	174	110	33	33	56	11	25	31	4	31	20	7	13	2	2	492	12	18	1	..	..	119	38	..	1,232
Louisiana & Arkansas	13	10	2	4	4	1	5	7	1	2	2	1	2	..	..	52	6	2	..	..	..	74	..	..	188
Midland Valley	27	24	4	14	16	1	6	9	1	4	4	1	1	..	1	86	..	2	..	..	..	22	12	..	235
Missouri & North Arkansas	17	16	2	9	10	..	3	4	..	3	3	1	3	..	..	52	6	..	..	..	..	33	50	..	212
Missouri, Kansas & Texas	316	296	61	133	180	19	72	91	8	63	52	14	79	18	3	1,012	137	27	18	..	1	58	39	2	2,699
Missouri, Kansas & Texas of Texas	257	261	41	109	144	18	53	51	2	39	28	3	87	12	2	667	62	21	..	..	..	42	10	..	1,879
Missouri, Oklahoma & Gulf	24	25	5	14	18	2	6	9	..	2	3	1	1	1	..	89	4	..	..	..	..	2	2	..	208
Missouri Pacific	1,099	986	194	476	484	65	218	310	21	208	163	20	163	15	3	3,175	239	80	2	1	..	477	29	13	8,441
St. Louis-San Francisco	905	555	133	296	285	46	110	129	16	208	118	25	181	53	13	1,440	125	29	1	..	..	91	10	6	4,775
St. Louis, San Francisco & Texas	34	42	7	12	19	3	7	10	..	6	9	2	2	..	..	57	..	..	..	..	..	14	..	..	224
St. Louis Southwestern	79	92	14	27	38	5	27	39	4	21	17	4	5	12	..	493	31	24	..	..	..	5	2	..	939
St. Louis Southwestern of Texas	66	65	11	30	55	5	19	41	2	12	12	2	5	..	..	236	59	..	..	..	..	4	2	..	626
San Antonio & Aransas Pass	59	53	15	21	34	8	11	18	..	12	8	3	7	..	..	195	27	2	..	..	..	7	..	..	480
San Antonio, Uvalde & Gulf	13	13	7	6	7	2	2	2	1	2	2	1	3	..	..	21	3	1	..	..	..	15	4	..	105
Texas & Pacific	328	302	70	156	186	18	62	87	10	60	62	10	19	8	1	607	56	56	5	7	..	396	45	..	2,551
Trinity & Brazos Valley	9	12	3	6	8	2	2	3	..	1	3	2	3	..	..	50	2	9	..	..	..	45	15	..	175
Vicksburg, Shreveport & Pacific	31	27	7	11	11	2	11	13	2	6	4	1	1	..	..	78	20	6	..	..	..	5	35	..	271
Wichita Falls & Northwestern	1	2	..	2	3	..	..	..	..	..	..	..	1	..	..	11	..	..	..	..	..	7	7	..	34
	3,977	3,268	763	1,614	1,840	256	726	1,002	81	774	575	119	598	131	34	10,165	949	371	27	8	1	1,709	364	22	29,374
Ratio	....	1.2	5.2	....	.8	6.3	....	.7	8.9	....	1.3	6.5	....	4.5	17.6	....	10.7	27.4	....	3.3	27.0	....	4.7	77.6	......

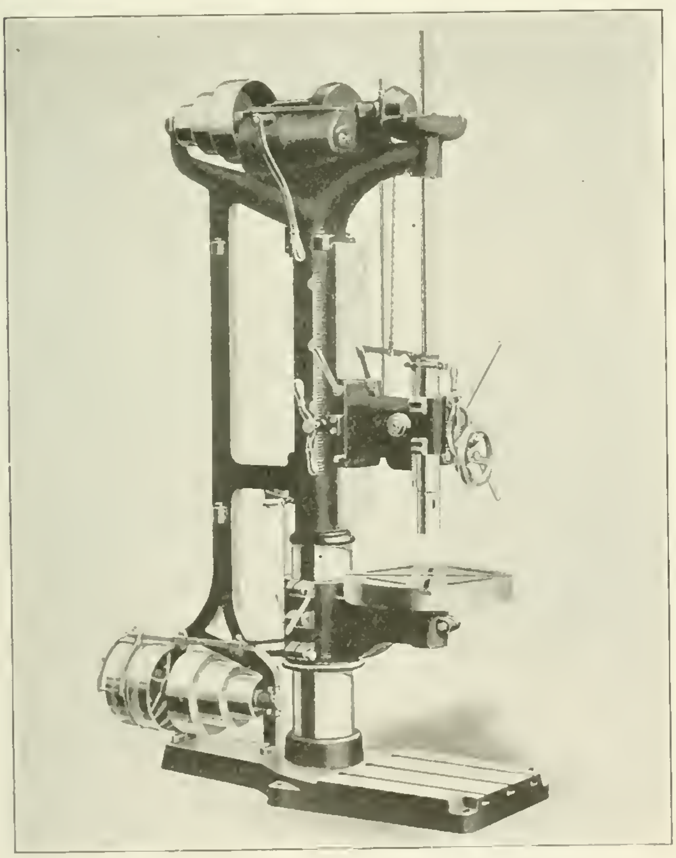
TABLE VIII—MECHANICS, HELPERS AND APPRENTICES IN ALL DEPARTMENTS, BY CRAFTS—ALL REGIONS

Railroad	Machinists: Machinists	Machinists: Helpers	Machinists: Apprentices	Boilermakers: Boilermakers	Boilermakers: Helpers	Boilermakers: Apprentices	Blacksmiths: Blacksmiths	Blacksmiths: Helpers	Blacksmiths: Apprentices	Sheet Metal Workers: Sheet Metal Workers	Sheet Metal Workers: Helpers	Sheet Metal Workers: Apprentices	Electrical Workers: Electrical Workers	Electrical Workers: Helpers	Electrical Workers: Apprentices	Carmen: Carmen	Carmen: Helpers	Carmen: Apprentices	Moulders: Moulders	Moulders: Helpers	Moulders: Apprentices	Other Mechanics: Other Mechanics	Other Mechanics: Helpers	Other Mechanics: Apprentices	Grand Totals
	....	1.5	6.7	....	1.2	12.4	....	.9	24.0	....	2.4	23.5	....	3.0	21.8	....	8.2	130.8	....	2.0	15.9	....	2.4	56.9	......
Eastern	16,302	10,635	2,421	5,250	4,238	421	2,564	2,635	107	2,873	1,204	122	4,609	1,505	211	41,106	4,965	314	254	123	16	6,948	2,865	122	111,864
	....	1.9	11.0	....	1.6	25.2	....	.9	43.8	....	2.7	38.9	....	4.6	23.4	....	6.0	303.0	....	1.4	49.5	....	6.7	423.3	......
Allegheny	20,995	10,576	1,883	5,639	3,508	227	2,891	3,002	66	3,704	1,353	95	5,336	1,160	228	36,009	5,980	119	495	338	10	6,774	1,009	16	111,463
	....	1.7	5.3	....	1.1	5.6	....	.8	14.7	....	2.1	5.2	....	3.8	17.7	....	7.5	52.1	....	.4	4.4	....	3.0	0	......
Pocahontas	2,342	1,343	437	553	467	98	369	469	25	414	193	80	587	154	33	6,987	929	134	62	154	14	524	174	0	16,583
	....	1.4	4.5	....	.9	5.2	....	.7	9.1	....	1.4	5.7	....	3.0	14.5	....	9.1	31.3	....	1.1	10.0	....	9.5	989.4	......
Southern	6,628	4,746	1,474	2,221	2,357	421	1,165	1,656	127	1,200	713	209	1,072	350	74	21,106	2,312	674	213	186	20	6,926	729	7	56,586
	....	1.5	4.3	....	1.04	6.7	....	.7	12.6	....	1.04	11.6	....	5.3	16.7	....	7.5	84.3	....	2.07	8.1	....	3.8	335.5	......
Central Western	10,040	6,679	2,296	3,558	3,407	527	1,396	1,736	111	2,290	1,230	196	1,676	313	100	24,622	3,003	292	81	39	10	1,342	346	4	65,086
	....	1.4	6.1	....	1.08	10.9	....	.7	22.9	....	2.3	16.4	....	5.2	6.5	....	16.2	299.2	....	2.8	181.0	....	6.1	531.2	......
Northwestern	7,315	5,081	1,188	2,613	2,591	239	1,514	1,980	66	1,200	549	73	1,477	285	226	23,643	1,462	79	181	64	1	4,250	695	8	56,810
	....	1.2	5.2	....	.8	6.3	....	.7	8.9	....	1.3	6.5	....	4.5	17.6	....	10.7	27.4	....	3.3	27.0	....	4.7	77.6	......
Southwestern	3,977	3,268	765	1,614	1,840	256	726	1,002	81	774	575	119	598	131	34	10,165	949	371	27	8	1	1,709	364	22	29,374
Ratio	....	1.6	6.5	....	1.2	9.8	....	.9	12.9	....	2.1	13.9	....	3.9	16.9	....	8.3	82 5	....	1.4	18.3	....	4.6	159.6	......
Totals	67,600	42,328	10,462	21,448	18,428	2,189	10,625	12,480	533	12,455	5,617	894	15,355	3,898	906	163,638	19,600	1,983	1,313	912	72	28,473	6,182	179	447,770
	....	2.2	53.5	....	....	....	....	1.0	....	....	4.9	55.4	....	10.4	18.9	....	6.9	5.2	....	....	....	....	....	....	......
Pullman Lines	107	49	2	....	....	....	46	48	....	388	79	7	698	67	37	2,171	315	42	....	....	....	....	....	....	4,056
Average ratio	....	1.6	6.5	....	1.2	9.8	....	.9	20.0	....	2.2	14.3	....	4.0	17.0	....	8.3	81.9	....	1.4	18.3	....	4.6	159.6	......
Grand Totals	67,707	42,377	10,464	21,448	18,428	2,189	10,671	12,528	533	12,843	5,896	901	16,053	3,965	943	165,809	19,915	2,026	1,313	912	72	28,473	6,182	179	451,826



SLIDING HEAD DRILLING MACHINE

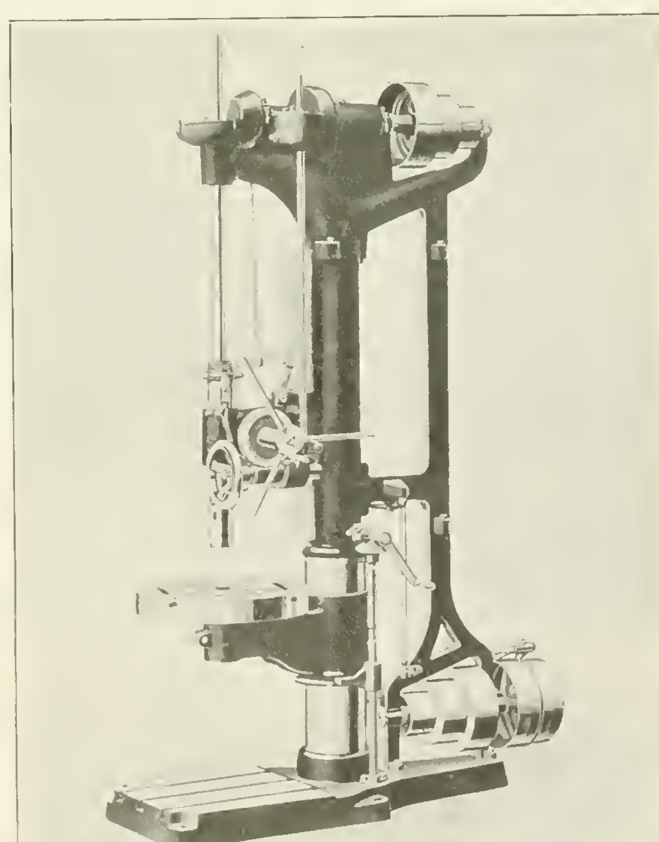
An upright sliding head drilling machine built by the Sibley Machine Company, South Bend, Ind., includes several new features not found in preceding types. The machine as now being built has a swing of 24 in. and the 25-in. vertical adjustment of the head makes it possible to drill work held in large jigs. Positive geared feeds are provided and both speeds and feeds are selective and have a wide range. To insure strength and rigidity for heavy duty the base of the drill is well ribbed and braced. Increased length of bearings on the head and the arm and substantial table support give added strength and accuracy. A weight to counterbalance the head and the spindle is supported inside the column by a Diamond chain operating over large diameter sheaves. All gears are enclosed to insure the safety of the operator and belt guards can be furnished if desired.



Sliding-Head Drilling Machine With the Cast Bearings

The fitting of all drive shaft bearings with die-cast split bushings made of anti-friction metal is stated to be an exclusive feature of this machine. These bearings are easily interchangeable and their use insures a long life for the bearings. Attention is called to the new geared feed with four changes and a neutral position. The feed changes are obtained by moving a knob conveniently located in the center of the handwheel, in connection with a sliding spline, four feeds being provided for each spindle speed. The initial drive of the feed shaft is from the top cone shaft through spur and spiral gears. This arrangement is very compact so the gears can be completely enclosed and run in an oil bath. The steel worm which meshes with the large worm gear also runs in an oil pocket.

The adjustable automatic stop of new design is quick and positive in action. Hand feed and quick return of the spindle is effected through the medium of a three-legged spider, at the right of the feed box. Special attention has been given to the oiling of the machine. All bearings are equipped with oil cups, grooves and channels, which insure a proper dis-



Four Feed Changes are Obtained Through the Feed Gears and Spline

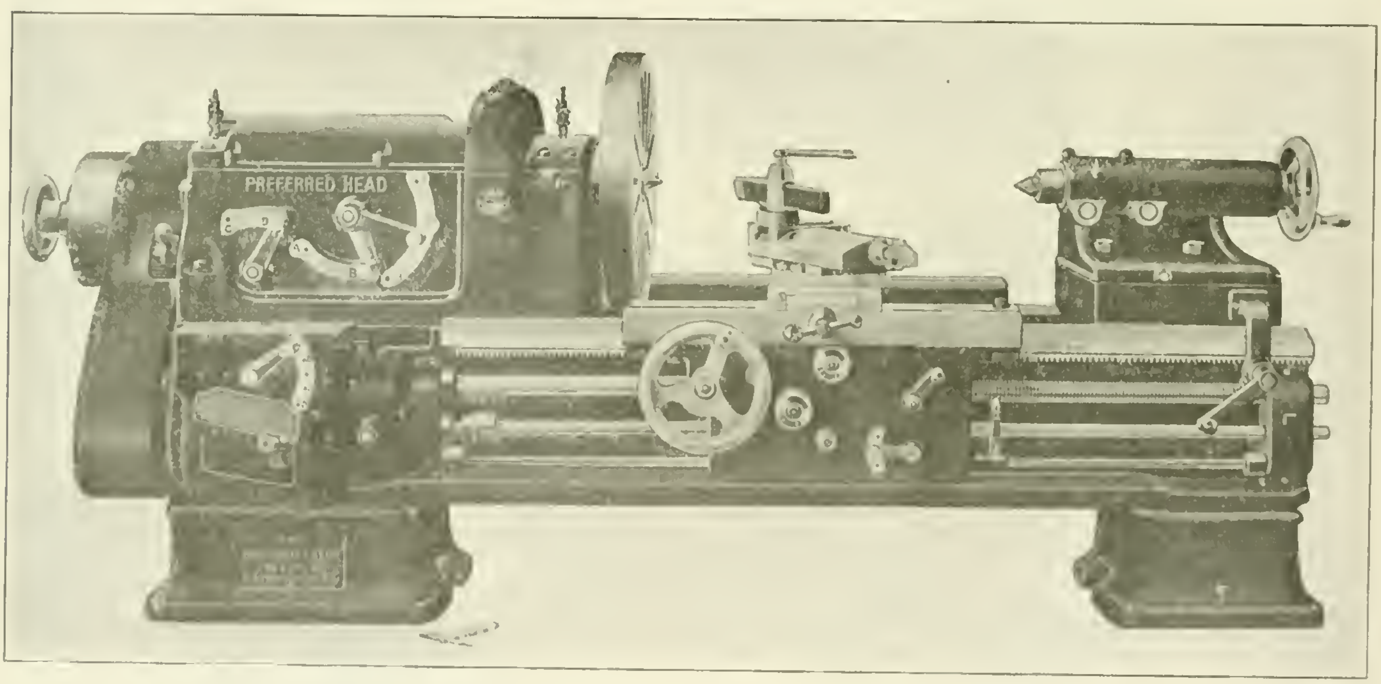
tribution of oil to the vital points. All feed gears in the feed case are completely enclosed and run in oil. A positive geared tapping attachment, geared or belted motor drive, round or square table with T-slots and oil pocket, oil pump outfit complete and quarterturn countershaft can be furnished as special equipment with this machine. The total height of the drill is 94 in. and the maximum distance from the spindle to the table and base are $35\frac{1}{2}$ in. and $52\frac{1}{2}$ in., respectively, while the head and the table have a traverse on the column of 25 in. and 13 in., respectively.

GEARED HEAD LATHE

The patented geared head lathe illustrated is manufactured by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio, and is arranged for single-pulley belt drive, directly from a line shaft. The lathe may be arranged for direct motor drive by mounting the motor on the headstock or in the rear of the cabinet leg. In this case the drive is through belting, silent chains or gearing. Variations in speed are obtained in the head, therefore only constant speed motors are required. Twelve mechanical speed changes in geometrical progression are secured on these lathes by means of sliding gears. The movement of the gears is controlled by three shifting levers, and their operation and use is plainly indicated. The levers and gearing are so arranged that they will not lock while operating, and any lever may be shifted without interfering with the others.

The index plates are simple and easily read, so that the most inexperienced operator will have no trouble in obtaining any speed or feed desired. The spindle may be stopped by the usual control lever on the right of the apron.

The design of this lathe is somewhat similar to the line of lathes manufactured by the Cincinnati Lathe & Tool Company, except that the method of driving the spindle through the gears makes the lathe rather more adaptable to manufacturing work than to tool work. Abundant power is provided to drive the lathes under heavy cuts, and the easy and quick manipulation of operating levers has also been provided for. The latter can be provided with a hexagon turret if desired.



Geared Head Lathe Manufactured by the Cincinnati Lathe & Tool Company

LIMIT SCREW PITCH GAGE

In the past many screw pitch gages have been made with no tolerance and a normal lead only. A new development in these gages which adds to their usefulness is shown in the illustration. As indicated, two additional surfaces are provided on the reverse side, one of which is cut with a lead .002 in. long and the other .002 in. short, thus making a limit gage. When the old style of gage was laid in the thread of a screw it was possible to check the lead on the screw, but in case the lead was not correct, it was impossible to tell how much of an error existed.

Many tool room foremen favor a type of plug gage which unfortunately has the same disadvantages mentioned above and in addition is susceptible to inaccuracies due to wear and is a time consumer in use.

With the new style gage illustrated, if the thread to be

Greenfield Limit Screw Pitch Gage

tested is not normal it can be determined readily whether the thread is longer or shorter than the limit portion of the gage, or whether the error is between these limits. The gages are made for the present to control lead limits of plus and minus .002 in., which is the most generally used lead limit. Eventually it is intended to supply gages with tolerances of .001, .003 and .004 in. for both long and short lead.

When using the gages it is essential that the work being tested, as well as the gage, is clean in the thread and that the gage is held in the screw in a position parallel to the axis. In testing the thread with this gage the work should be held up to the eye in front of a bright light, so that the resulting error in lead can be detected easily. The gage is manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass.

MARTIN TOOL HOLDER

The tool holder illustrated, has been designed for use with broken and worn high speed steel drills and tool bits, and is manufactured by the Martin Tool Holder Company, Jackson, Tenn. The body of the holder is made of tool steel, and will last practically indefinitely. The cutting edge of the tool, being made of broken high speed steel drills, reamers, etc., will stand up under heavy cuts, and there is a saving of expensive high speed steel scrap, which would otherwise be of no value save for the expensive operations of remelting and reforging.

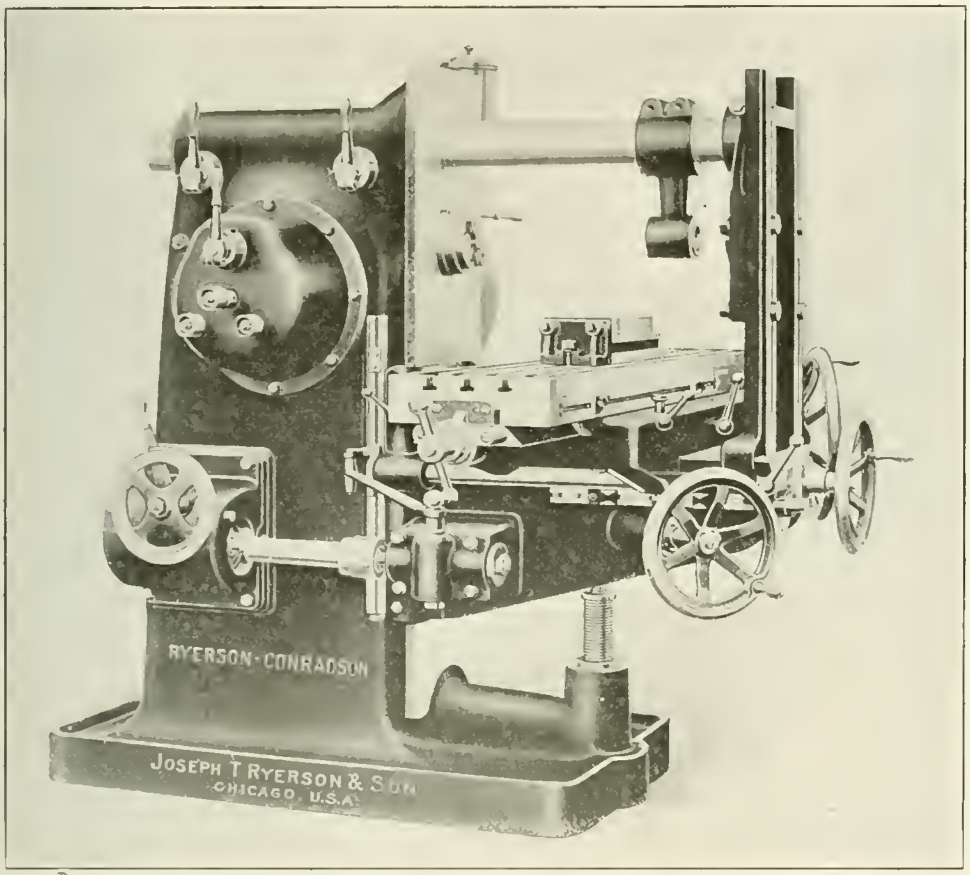
The method of holding and grinding the tool bit is clearly shown in the illustration, and either round or square bits can be utilized. It is claimed that this form of tool holder is capable of taking cuts limited only by the power of the machine.

Tool Holder Designed for Use With Broken High Speed Steel Drills and Tool Bits

Martin tool holders are made in all standard sizes, and the absence of large bosses or set screws, saves much of the operator's time previously spent in handling, grinding and changing heavy solid tools. The resulting economy is obvious.

HIGH POWER MILLING MACHINE

The milling machine, designed for high production, is now recognized as a more or less universal tool, and there has been a steady increase in the range of work that can be performed on it. Great power, rigidity, convenience of operation and adaptability to light or heavy manufacturing or jobbing work is provided for in the new No. 3 plain milling machine recently placed on the market by Joseph T. Ryerson & Son, Chicago. The most striking feature in the design of this machine lies in the application of the helical drive. When this form of drive is used the constant turning power applied to the milling cutter not only insures a better grade of work, but increases the life of the cutter. The objection to helical drive gearing in the past has been the inability to secure a sufficiently wide range of speeds for a commercial machine, but this difficulty has been overcome in the machine illustrated.



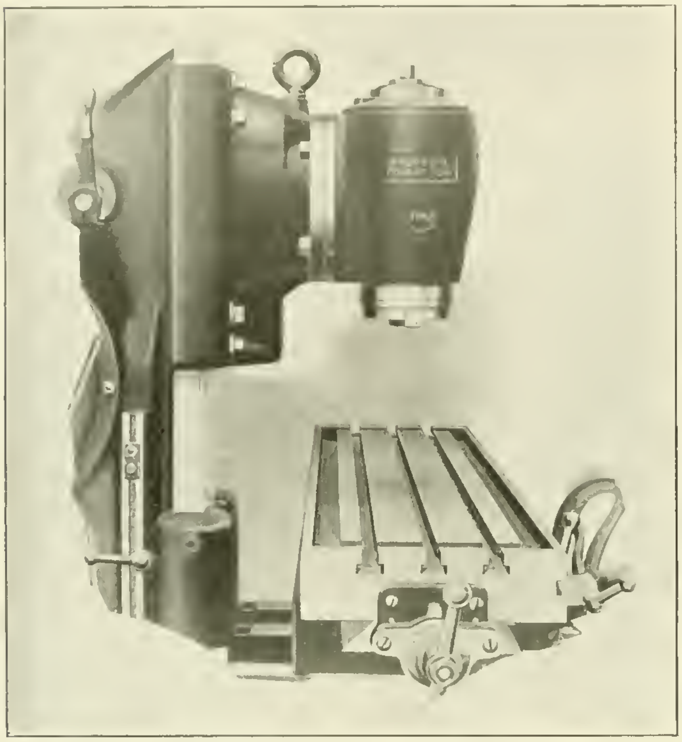
Front View of Ryerson-Conradson No. 3 Plain Miller

The column is a rigid casting, thoroughly ribbed internally and cast integral with the base. The face of the column is extended above the over-arm, thus affording a very thorough support for special fixtures. The heavy type vertical milling attachment with this solid backing is capable of taking as heavy a cut as the main spindle. The knee is heavy and deep, absorbing vibration due to heavy cuts. The bearing surface between the knee and the column is greatly increased by extending the back of the knee up to a point nearly level with the top of the table. The elevating screw telescopes the knee, and is located at its center of gravity to avoid all binding action when raising or lowering. The handwheel controling longitudinal table travel extends diagonally from the side of the saddle. The spindle is of .60 carbon steel, accurately ground and runs in phosphor bronze bearings, which are adjustable for wear. The base plate is forged integral with the spindle and is arranged with two large keys for driving face mills and arbors. Twelve spindle speeds are available, ranging from 17 to 290 r.p.m. in practically geometrical progression. The driving pulley is of the conical friction clutch type and means are provided to automatically apply a brake to the shaft as soon as the clutch is disengaged.

The feed drive is positive from the primary shaft by means of a chain and sprocket. Eight changes are provided, ranging from .6 in. to 22.3 in. per minute. Each feed screw is provided with a graduated dial reading to thousandths of an inch and readily set back to zero. All feeds are equipped with six trips and the table can be stopped at any desired position along its travel.

The vertical milling attachment illustrated is made in three sizes, and clamped to the column dove-tail, no dependence being placed on the over-arm. The heavy pattern type has the same diameter spindle and the same bronze bearing as the main spindle. The taper hole face plate and driving keys also are the same, permitting as heavy a

cut to be taken as on the horizontal spindle. This is a particularly important feature. The drive is effected by a large aluminum bronze gear, bolted to the face plate of the main spindle and driven by the cross key. In return it engages a steel gear on a horizontal shaft, driving the vertical spindle through a set of bevel gears. This allows the spindle to be set at any angle parallel to the face of the column. A draw bolt is furnished.



Vertical Milling Attachment of Semi-Universal Type

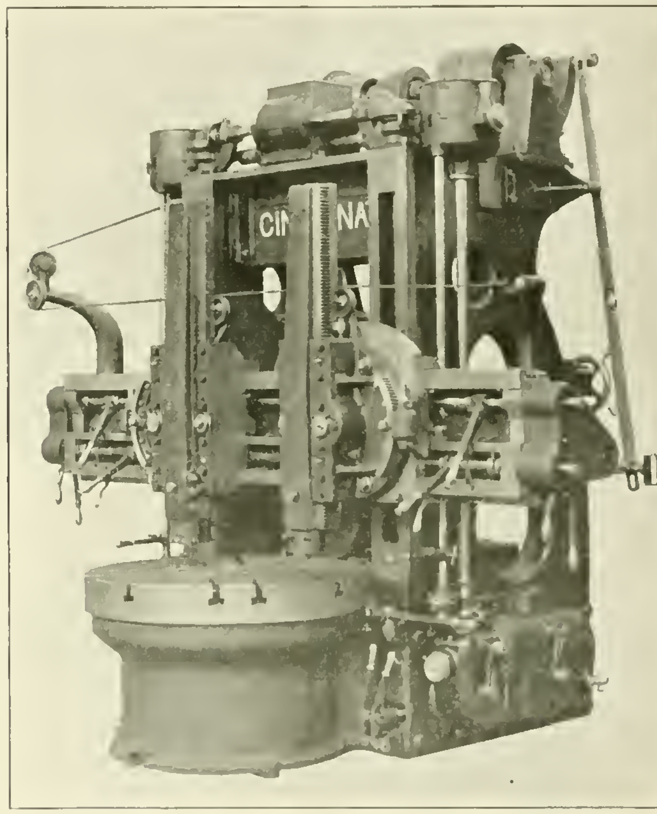
The longitudinal movement of the table is 35 in., with a cross movement of 14⅝ in. and vertical movement of 20 in. The machine is driven at a constant pulley speed of 600 r.p.m., requiring a motor of from 5 to 7½ rated horsepower.

MEDIUM SIZED BORING MILLS

With an appreciation of the need of a boring mill to take heavy cuts on medium and small sized work, the Cincinnati Planer Company, Cincinnati, Ohio, has recently added to its line of boring mills a new machine built in 42 in. and 48 in. sizes, one of which is shown in the illustration. These are high production machines, built to take heavy cuts at high speed. They have a capacity of two inches over the rated size, and take 39 in. under the tool holder.

The table is driven by a large, accurately planed bevel gear. The large bevel pinion which meshes into it has a double bearing in the bed, thus insuring smooth motion of the table. Among other advantages may be mentioned the fact that the spindle and track, and also all bearings in the speed box, are oiled by forced lubrication. The bed is reinforced by heavy I-beam ribs and is bored out and bushed for all revolving parts. No pit is necessary for the driving mechanism. All gears in the feed and speed boxes are made of steel, and the enclosed feed boxes are provided with direct reading feeds. Rapid power traverse of the head is provided in each direction, and the traverse handle is adjustable to suit the operator. As a safety feature, the crank handle cannot be engaged when the rapid power traverse is used. Sensitive adjustments are provided for both heads. The housings are of box type construction and extend to the bottom of the bed. They are held in alinement with the bed by a tongue and grove. All gearing is completely covered and the steel feed racks have teeth cut the entire length.

The travel of the tool bar is 27 in. Eight feeds are provided, ranging from 1/40 in. to ½ in., and the range of table speeds is from 2.45 to 59.2 for the 42-in. size, and 2.1 to 50.5 for the 48-in. size. A 10-hp. motor is required to drive either of these boring mills, and if direct current is available, a 2 to 1 variable speed motor, not exceeding 500 to 1,000 r. p. m. is recommended. For variable speed motor drive, the cone pulleys are omitted and a single belt drive used instead. The motor is mounted on top of the arch and coupled directly to the driving shaft, as shown in the illustration. Boring mills of this type can be equipped with countershaft drive and a belt shifter, if desired. They can also be furnished with a constant speed motor on the arch, in place of the tight and loose pulleys.



Cincinnati Boring Mill Built in 42-in. and 48-in. Sizes

Ease of manipulation and the proper placing of all control handles has been constantly kept in mind in the design of these 42-in. and 48-in. boring mills, and all unnecessary steps around the machine have been eliminated.

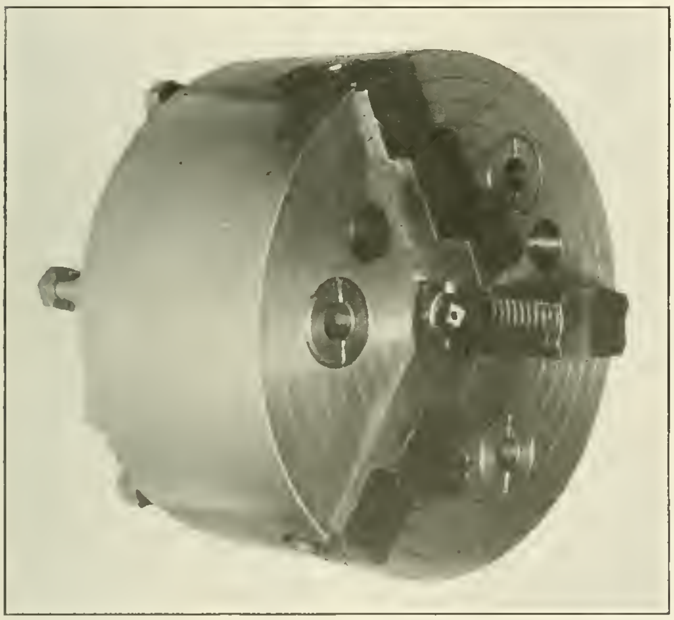
LAVOIE AIR CHUCK

About four years ago an air chuck was developed in a large manufacturing plant which was producing war material, and was the means of turning out a large production of small lathe work. This air chuck proved so satisfactory in operation that steps were taken to commercialize it, and it is now being manufactured by the Frontier Chuck & Tool Company, Buffalo, N. Y. While this chuck has been manufactured for only about six months, it is by no means a new and untried tool. It is a new departure in air chucks, owing to the fact that the component parts are all embodied in one unit.

The chuck cylinder and piston is an assembled unit,

mounted on a chuck base plate, which is attached to the spindle in the same manner as with an ordinary chuck. This feature greatly simplifies the application. The single unit is of such size as to insure rigidity and strength and because there is but one packing, the usual complications found in this class of equipment are eliminated. It is stated that the lever and wedge which control the action of the jaw embodies a positive clamping action, which is original with the Lavoie chuck. Due to its simplicity, the chuck may be expected to give satisfactory service over a long period of time. The packing used in the Lavoie chuck is of the cup leather type, and is applied to the piston by means of a ring and screws of such size as to insure saving of time on renewals.

The chuck is made in five sizes, varying from 8½ in. to 18 in., the length of the chuck from the spindle end to the face ranging from 6⅛ in. to 5¼ in. Six types of jaws are provided, varying from universal solid manufacturing jaws to combination three-step jaws for general chucking



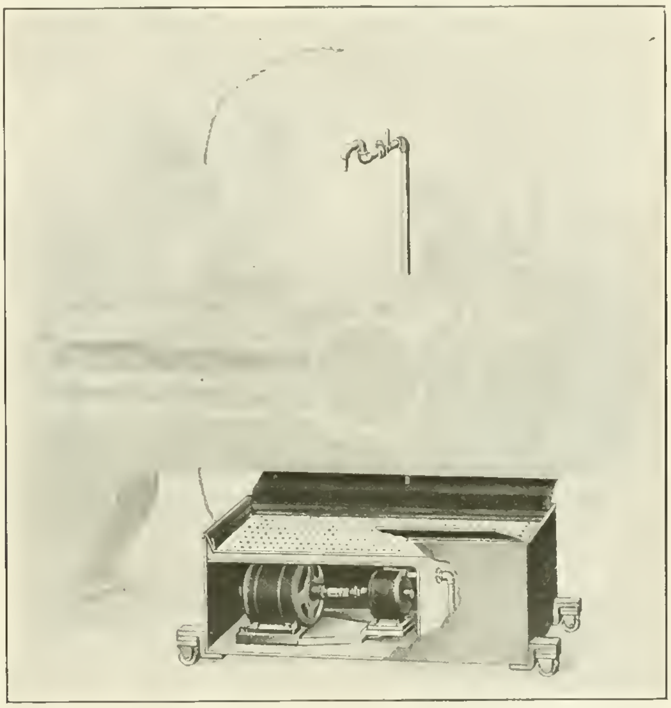
Air Chuck Manufactured by the Frontier Chuck and Tool Company

work and combination solid or detachable manufacturing jaws. An air box is used in connection with the Lavoie air chuck, and is necessary in order that the air pipe line can revolve with the spindle. The operating valve is a three-way cock, lever operated. One opening connects with the air supply, the second with the cylinder, and the third with the jaws. By the use of this valve only one pipe line is required.

PORTABLE LUBRICATING UNIT

The general design of a compact lubricating unit, manufactured by the Fulflo Pump Company, Blanchester, Ohio, is shown in the illustration. This portable unit was designed to fill the demand for a compact, inexpensive cutting tool lubrication system that could be quickly applied to any machine tool in the shop. Many machine shop tools are not equipped with a pan and pump, because they are used mostly for working on grey iron, but occasionally the machine may be used on malleable iron or steel, in which case a coolant is essential for the best results. In such cases, the portable unit illustrated can be used to good advantage. It may also be used on machines already provided with a coolant system, which for some reason or other is out of order. In this emergency the portable system shown can be immediately brought into place and production will not be interrupted.

The Fulflo pump illustrated is a complete, self-contained system, requiring nothing but attaching the motor cord to the lamp socket. The total height from the floor is only 14 in., which permits its being rolled under any ordinary lathe, as shown in the illustration. Provision is made for attaching additional splash boards when required. The pump and motor are completely covered, thus affording



Fulflo Portable Lubricating Unit Used with Turret Lathe

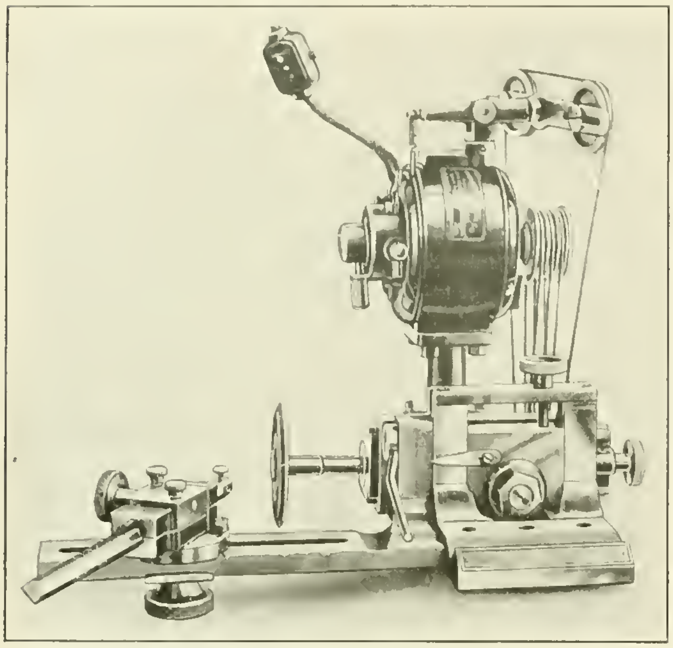
ample protection from both liquids and dust. The outfit can be used on grinding machines as well as on lathes, milling machines, drill presses, gear cutters, etc. There is only one moving part in the pump; namely, the impeller, which has no metal contact, and therefore cannot wear out quickly. It is packed with metallic packing which will not cut the shaft. The bearings are well lubricated, and since the shaft is hardened and ground, long, continued service may be expected.

MULTI GRADUATED PRECISION GRINDER

It has been difficult in the past to machine screw thread surfaces with the same accuracy obtained in machining cylindrical, flat or spherical surfaces. On account of this fact, it has been hard to make master thread gages and the machine illustrated was designed for this purpose by the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa. It can be used in conjunction with any machine tool and is adaptable to a variety of work, particularly thread grinding on lathes. The model *C* grinder illustrated is a right-hand attachment for use in front of the lathe center. Attention is called to the new style of wheel trueing arm, which is now attached to the base of the grinder in such a way that the thread angle is dressed on the wheel on a plane with the axis of the work centers, thus insuring a perfectly formed thread. This model also has a positioning pin for quickly locating the angle for V. U. S. and Whitworth threads.

The grinding spindles are carried in five precision ball bearings adjustable for radial wear and end thrust play. They are protected from abrasive dust by felt-lined steel

bushings. The spindle housing, carrying these ball bearings is provided with an oil reservoir, insuring continuous lubrication. The style of spindle bearings precludes the possibility of getting out of alinement, as in the case of solid bearings. Vibration and chatter are eliminated by making



Model C Precision Thread Grinder

the base and spindle housing proportionately massive and of solid construction. The spindle housing fulcrums in a vertical traverse plate and is indexed with graduations for setting to any angular inclination to conform to the helical angle of the thread.

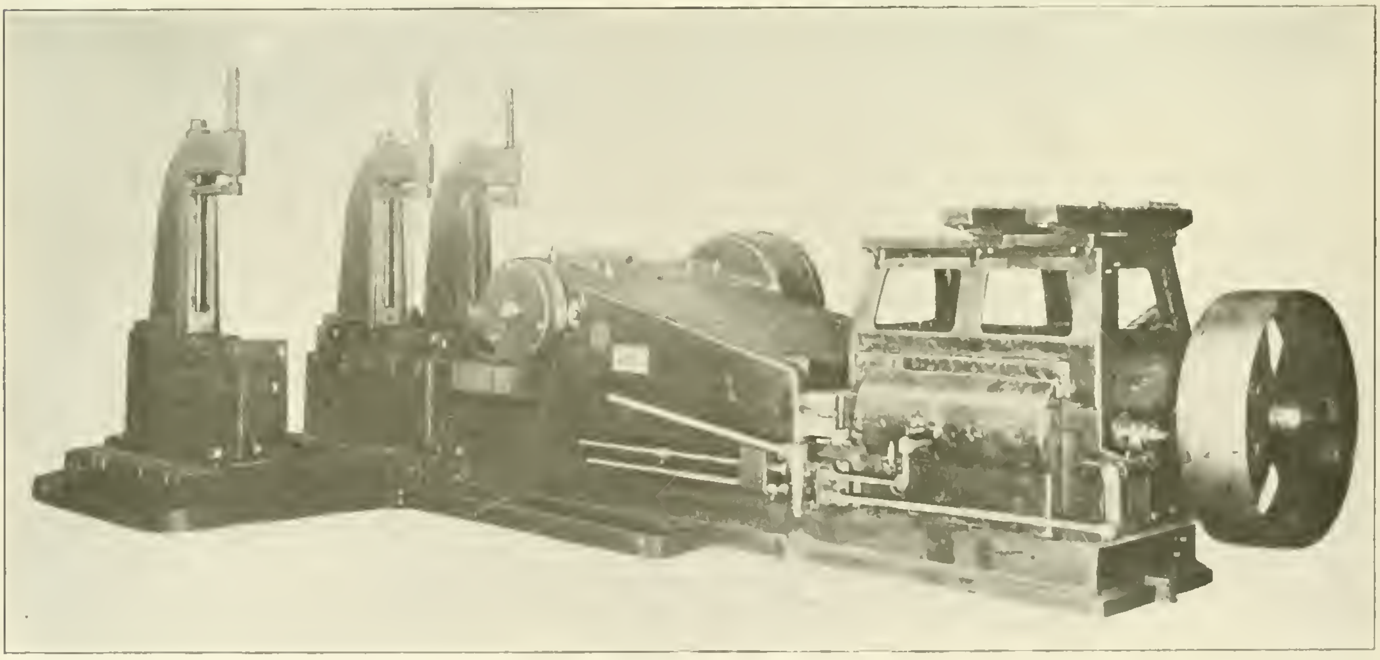
The machines are equipped with individual motors of any specified voltage and either direct or alternating current may be used. The power transmission is accomplished by means of an endless belt indicated, which has a three-point contact with both the driving and driven pulleys, and then travels over a compensating two-pulley arrangement, which automatically keeps it at the proper tension to prevent slipping, and at the same time allows slack enough to prevent loss of power and overheating. The capacity of the machine is limited only by the size of the lathe to which it is attached.

COLD SAW CUTTING-OFF MACHINE

A recent development in cold saw machines for cutting off large ingots and heavy forgings, has been made by the Newton Machine Tool Works, Inc., Philadelphia. This cold saw is equipped with a 76-in. diameter inserted tooth saw blade, which has a capacity for cutting 24-in. diameter stock in one cut. The main work table bolted to the machine base is 56 in. long in the direction of the feed of the saw and 48 in. wide. To this table there is bolted a platen 60 in. long by 56 in. wide by 12 in. deep, with suitable T-slots. On this platen there is a clamping block 18 in. wide at the base and 12 in. wide at the top. This block is in line with the top of the main table referred to above. Two V-blocks are fitted to the main work table and one V-block is fitted to the platen. A swivel arch clamp is supplied for each of the V-blocks, and these are so arranged as to hold work 32 in. in diameter.

The drive of the machine is from a belt-connected motor through a solid bronze worm wheel and hardened steel worm fitted with roller thrust bearings. A spur pinion with teeth cut in the solid shaft transmits the power to the spindle driving gear. The feed motion is taken from the drive shaft through gears to the oil-tight feed box in which the change gears are mounted on a sliding sleeve controlled by latch levers in the cover. From this box the motion is transmitted to the saddle feed screw through a feed worm and worm wheel which is positively clutched.

The control of the machine is from the rear. The forward feed is provided with an automatic stop, and the rapid traverse forward and back also has an automatic stop. The feed and rapid traverse mechanism is enclosed with



Powerful Cold Saw Cutting-Off Machine Designed to Use 76-in. Diameter Inserted Tooth Saw

curtain covers. Positive safety release is provided for each extreme position of the traverse. The oil and chip pan is cast on the base and drains the lubricant back to the reservoir. A loose chip pan is fitted between the tables for draining to the base oil pan.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue, 12,100 copies were printed; that of these 12,100 copies 11,177 were mailed to regular paid subscribers; 20 were provided for counter and news company sales, 223 were mailed to advertisers, 32 were mailed to employees and correspondents, and 648 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 36,300, an average of 12,100 copies a month.

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The Paducah, Ky., roundhouse and shops of the Nashville, Chattanooga & St. Louis, which have been idle since the beginning of the war, are to reopen on March 1.

Employees killed on the railroads of the United States, operated by the government, in the month of November, 1919, numbered 231 and employees injured 10,191, as compared with 359 killed and 11,248 injured in November, 1918. These are the totals shown in Bulletin No. 12, issued by the Safety Section, United States Railroad Administration.

Circular 263 of the Southwestern regional director cites a gasoline fire which resulted in a loss of $8,620, due to the negligence of a car repairer who worked on a leaky tank car with an open flame lantern, in violation of all regulations. The bulletin emphasizes the importance of observing all rules governing the transportation of explosives and other dangerous articles.

The Railroad Administration and the principal railroad companies have adopted the plan which has been reported from time to time as the negotiations have progressed for the financing of the equipment ordered by the Railroad Administration in 1918 by means of individual equipment trusts, payable in 15 annual instalments, with the Guaranty Trust Company of New York as trustee.

An abstract from the Times' Trade Supplement states that the Colombian railways are at present in great need of new rolling stock. In the very near future extensions are to be made, and this will create a demand for locomotives, coaches and freight cars. There will also be a large demand for permanent way materials owing to the reconstruction of large sections of the Colombian railways.

Because of the very disadvantageous rate of exchange, directors of several of the English railroads have issued instructions that no purchases are to be made in America except where it is absolutely impossible to obtain the same products elsewhere. Lines are being drawn more closely day by day against purchases in America by the railways in all European countries, due to the great disparity in the value of money. Furthermore, the railways in every country are making, as never before, every attempt to make purchases within their own frontiers. This will have a serious effect on English business, which relies to such a very great extent on its export business to balance the necessary imports.

New Fuel for French Locomotives

The Paris, Lyons & Mediterranean has decided to adapt 200 of its locomotives to crude oil or Mazout. The modification is expected to be effected at the rate of two engines a day. Reserve tanks will be set up at suitable points on the system to hold between 40 and 100 tons of fuel.

The plant modifications are neither difficult nor costly, being simply a reservoir in place of the coal bunkers, conducting tubes to the burners and refractory bricks in the firebox.

At an official test held at Bercy on November 25, the locomotive drew a heavy goods train on approximately half the weight of fuel which would have been necessary for the work if coal had been used. There is practically no smoke and it is expected that this fuel will save much labor in the enginehouses.

Investigation of Chilled-Iron Car Wheels

It has been noted for several years that failures of chilled cast iron freight-car wheels occur quite frequently at the foot of long and steep grades. The cause of such failure appears to be the heating of the wheel produced by the prolonged application of the brake-shoes, this rise in temperature causing complicated stresses in the structure of the wheel. The stresses thus produced may be sufficient to cause cracking and failure and in all probability a derailment of the car under which the wheel is placed.

In order to determine the exact temperatures in different portions of the wheel, after prolonged heating of the rim, the Bureau of Standards has instituted a complete investigation of this subject. It is obvious that temperature measurements can not readily be made upon a wheel in service, and considerable ingenuity has been shown in perfecting a laboratory apparatus capable of producing conditions analogous to those met with on the road.

Australia Manufacturing Railway Supplies

Several Australian engineering firms have taken up the manufacture of railway supplies and the Chief Commissioner for Railways, James Fraser, of New South Wales, has expressed complete satisfaction with the local products. He said that he had been pleased to give preference to Australian

manufactures, and he had not had to pay higher prices than for goods of the same quality from foreign sources. The New South Wales railway administration has been making axles, wheels and tires for both freight and passenger cars in its own shops, and shortly everything required for making a locomotive, with the exception of boiler plates and copper tubing and plates, will be made in Australia, and even the latter will be produced in Australia before long. Mr. Fraser said that he had been promised delivery next March of copper tubes by an Australian manufacturer at a slightly lower figure than that for which he could get copper tubes abroad.

The New Zealand government has placed a contract with an Australian shop for 20 express locomotives. This shop has already turned out over £300,000 worth of work, to the complete satisfaction of the New Zealand railways.

Locomotive Building in Belgium

According to a recent report on the subject of locomotive production in Belgium, says the Railway Gazette, London, there were in that country prior to the war 20 factories in which the construction of railway engines was undertaken. The whole of these were damaged very considerably by the German army and most of the plant removed, one factory being completely destroyed. The work so far undertaken since the cessation of hostilities has been limited to the repair of the buildings and plant, and, as far as has been possible, replacement of the shop equipment. The shortage of engines and the poor condition of those available give scope for immedate activity in this branch of industry, but the shortage of fuel, the difficulty of obtaining raw material, etc., want of capital and the exorbitant demands of the workmen, all stand in the way of progress. The total number of workmen at present employed is 4,542, or about 75 per cent of the number employed in 1913, and these are engaged in repairing locomotives for the State and branch railways. The raw material for a few engines on order in 1914 was hidden and escaped the capacity of the invaders, and the completion of these engines, with a construction of a few others, form today all that the Belgium workshops are able to do in the matter of locomotive production.

Changes in Erie Railroad Organization

On the return of the railroads to private control a radical change will be effected in the official personnel of the Erie. The principal feature of the new plan is the establishment of four regions, each, with one exception, consisting of three or more operating divisions. Each of these regions will be placed in charge of a manager who, reporting to the general manager, will be in practically entire charge of all phases of work done in his particular region. With this in mind each regional manager is to have a regional engineer, a mechanical superintendent, a general freight and passenger agent, a superintendent of transportation, a claim agent, an auditor, an assistant treasurer, a storekeeper and a chief of police. The former divisional organization is to be retained and the superintendents of the several divisions will each report to the manager of the region in which they are included.

The general manager's organization is to consist of a general superintendent of transportation, a general mechanical superintendent, a chief engineer, a general storekeeper and an inspector police.

The regional engineer, regional mechanical superintendent, etc., will each report directly to the regional manager, but in order that their work may be properly co-ordinated they will also report indirectly to their respective officers on the general manager's staff or to the other officers at the head of the railroad organization as the case may be.

The four regions will be known as the New York region, Hornell region, Ohio region and Chicago region.

William Schlafge, formerly general mechanical superintendent with office at Meadville, Pa., has been appointed mechanical manager on the general manager's staff, with headquarters in New York.

The four regional mechanical superintendents are as follows: W. S. Jackson, New York region, Jersey City, N. J.; formerly mechanical superintendent of the Lines East, with office in New York. Charles James, Hornell region, Hornell, N. Y.; formerly mechanical superintendent of the Lines West, Youngstown, Ohio. A. G. Trumbull, Ohio region, Youngstown, Ohio; formerly assistant to the general mechanical superintendent, Meadville, Pa. G. T. Depue, Chicago region, Chicago; formerly shop superintendent at Susquehanna, Pa.

Material Specifications for Tank Cars

The Mechanical Section of the American Railroad Association has recently issued Circular S III-92 giving notice that the suspension of the requirement for boiler plate steel, flange quality, for plates of class III tank cars, as authorized by circular No. S III-67, dated October 10, 1919, is hereby extended to continue in effect until April 1, 1920, only.

The material for all plates of tanks of class III tank cars built after that date must comply with section 2 (a) of the specifications for class III tank cars, 1919 edition, page 21, which reads as follows:

"Material—(a) For cars built after April 1, 1920, all plates for tank and dome shall be of steel complying with the American Society for Testing Materials specifications for boiler plate, flange quality."

The tank car specifications, as revised 1919, effective February 1, 1920, are now ready for distribution, and will be supplied at the following prices to members of the association: 100 copies or more $15 per 100; 50 copies $8; less than 50 copies, each 25 cents.

W. H. Woodin Says Railways Need 849,500 Cars

William H. Woodin, president of the American Car & Foundry Company, has made an investigation, as a result of which he estimates that the railroads of the United States will need 849,500 cars during the next three years. It is Mr. Woodin's opinion that while this need, if it is supplied, will run into a tremendous amount of money, the railroads will begin to renew their equipment once the carriers have been returned to private ownership, and that the money will be forthcoming to finance the undertaking. Unless measures to increase the efficiency of the railroads are consummated, he considers that there may be a serious interference with the normal ebb and flow of business. He draws attention to the fact that even now some factories have closed because, due to the car shortage, they cannot get materials.

To make up the present apparent shortage it is asserted 240,000 cars are needed. Replacement for retirement through the next three years will require 234,300 cars, and to take care of increased business it is estimated that 375,200 cars will be needed in the three-year period. The replacement figure is on the basis of an average retirement of 3½ per cent a year and the increased business on 5 per cent a year.

The following table shows the requirements for replacement and increased business during the three years:

	Replacement	To handle increased business
1920	73,500	118,500
1921	78,000	125,000
1922	82,800	131,700

These requirements, Mr. Woodin believes, are not beyond the capacity of the car builders of the country, but it is believed that under the present adverse conditions regarding purchase of steel and other materials it would not be possible to turn out more than 600,000 cars, or some 200,000 a year.

Electrical Workers Strike on St. Paul

Chicago, Milwaukee & St. Paul shopmen employed in the shops at Deer Lodge, Mont., recently engaged in an unauthorized strike because of a desire to force a decision in matters pending before the arbitration board at Washington.

As a direct result of the difficulty practically the whole electrified division of the St. Paul, extending from Harlowton, Mont., to Avery, Idaho, was operated with great difficulty. Federal officers of the road, on hearing of the strike of the shopmen, requested them to await arbitration. However, the shopmen refused, and 48 hours later the electrical sub-station operators on practically the whole electrically-operated division walked out in sympathy with the shopmen. Electrical experts and officers of the electrified division took the places of the sub-station operators as far as possible, and in many places on the division it was found necessary to use steam to maintain service. Director General Hines was immediately notified, and after stating that the sub-station operators' strike was in violation of their contract, issued a 48-hour ultimatum, and the men acceded to his request and returned on February 5. Approximately 300 shopmen and 40 sub-station operators were involved. During the strike some through passengers were detoured over the Northern Pacific.

Reorganization of the Pennsylvania System

The Pennsylvania System has been reorganized for operating purposes after March 1, and has been divided into four regions.

System officers have been grouped under an executive department having attached thereto a transportation department, a traffic department, a financial department, an accounting department, a purchasing department, a real estate department, a legal department, an insurance department, an employees' saving fund department, and a relief and pension department. Samuel Rea will, of course, be president, and reporting directly to him there will be a vice-president in charge of operation, W. W. Atterbury; a vice-president in charge of traffic, George W. Dixon; a vice-president in charge of accounting, A. J. County; a vice-president in charge of real estate, purchases and insurance, M. C. Kennedy; a vice-president in charge of corporate work at Pittsburgh, James J. Turner. There will be two secretaries, one at Philadelpiha, Lewis Neilson, and one at Pittsburgh, S. H. Church. In addition there will be a vice-president in charge of personnel, G. L. Peck, who will report to Gen'l. Atterbury.

The combined lines east and west of Pittsburgh have been divided into four sections: The eastern, from New York to Altoona, Pa., and Washington, D. C.; the central, from Altoona to Buffalo, N. Y., Columbus, Ohio, and Mansfield; the northwestern, from Columbus and Mansfield to Chicago; and the southwestern, from Columbus and Cincinnati to St. Louis, Mo. Each of these will be in charge of a regional vice-president. The four regional vice-presidents are Elisha Lee at Philadelphia, R. L. O'Donnel at Pittsburgh, J. G. Rodgers at Chicago, and Benjamin McKeen at St. Louis.

Each regional vice-president will have on his staff a general manager, a general superintendent of transportation, a chief engineer of maintenance of way, a general superintendent of motive power, general superintendents, a traffic manager, a purchasing agent, a real estate agent, and an accountant. On the eastern and central regions there are assistants to the general manager, general superintendents of transportation, etc., commensurate with the amount of business to be handled by the region.

The transportation department, headed by General Atterbury, will consist of a chief of transportation, C. M. Sheaffer, at Philadelphia, with assistants; a chief of motive power, J. T. Wallis, at Philadelphia; a chief mechanical engineer, A. W. Gibbs, at Philadelphia; an engineer of transportation, E. W. Smith, at Philadelphia, and a chief engineer, A. C. Shand, at Philadelphia, with a considerable staff of assistants.

The relations between the central organization and the regional organizations is particularly interesting and constitutes an entirely new departure for the Pennsylvania, although some features of it were inherent in the Harriman system of roads, as this system was being developed at the time of E. H. Harriman's death. It will be remembered that Mr. Harriman had a director of operation for the entire Harriman system. W. W. Atterbury, with the title of vice-president in charge of operation, might well have been designated director of operation. While each regional vice-president is responsible for traffic, maintenance and operation in his territory, General Atterbury's duties consist of co-ordinating the work of these officers in regard to both operation and maintenance. His supervision will therefore be more comprehensive than a mere setting of system standards. This is true also of the executive vice-presidents in charge of traffic, finance, accounting and purchases. While the regional vice-presidents have on their staff traffic and purchasing officers they can also avail themselves of the vice-presidents at Philadelphia as consulting experts.

The Altoona shops will be in charge of a works manager, P. F. Smith, Jr., with a shop accountant, an assistant chief of motive power (car), an assistant chief of motive power (locomotive), and a motive power accountant. In other words, the Altoona shops will be organized in much the same way as is an industrial manufacturing plant.

The following list gives the names of mechanical department officers their new titles, positions and headquarters.

System Officers

Name	*Title*	*Headquarters*
J. T. Wallis	Chief of motive power	Philadelphia
	(formerly gen. supt. motive power, Altoona)	
P. F. Smith, Jr.	Works manager	Altoona
	(formerly gen. supt. motive power, Lines West, Pittsburgh)	
J. R. Black	Shop accountant	Altoona
R. L. Kleine	Asst. chief of mot. pwr. (car)	Altoona
	(formerly chief car inspector, Altoona)	
F. W. Hankins	Asst. chief mot. pwr. (loco.)	Altoona
	(formerly master mechanic, Altoona)	
G. M. Ellsworth	Motive power accountant	Altoona
A. W. Gibbs	Chief mechanical engineer	Philadelphia
E. W. Smith	Engineer of transportation	Philadelphia
	(formerly supt. motive power, Cent. Div., Williamsport)	

Eastern Region

J. M. Henry	General supt. motive power	Philadelphia
	(formerly asst. gen. supt. motive power, Altoona)	
Eliot Sumner	Supt. motive power, N. J. div.	New York

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 9	Locomotive Valve Motion	F. Williams	W. A. Booth	131 Charron St., Montreal, Que.
Central	Mar. 12	The Labor Situation Today and Tomorrow	F. H. Hardin	H. D. Vought	95 Liberty St., New York.
Cincinnati	May 11			H. Boutet	101 Carew Building, Cincinnati, O.
New England	Mar. 9	Annual Meeting and Entertainment		W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Mar. 19	The Automatic Stop Problem	H. S. Balliet	H. D. Vought	95 Liberty St., New York.
Pittsburgh	Mar. 26			J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Mar. 12			B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Mar. 15			J. M. Byrne	916 West 78th St., Chicago.

C. B. Keiser......Supt. mot. pwr., E. Pa. div....Harrisburg
(formerly supt. motive power at Wilmington, Del.)
Amos Davis......Supt. mot. pwr., Southern div..Wilm'gton, Del.
(formerly master mechanic, Wilmington, Del.)
Robert Bennett...Supt. mot. pwr., Cent. Pa. div..Williamsp't, Pa.

CENTRAL REGION

H. H. Maxfield...Gen. supt. motive power.......Pittsburgh
(formerly works manager, Altoona)
C. L. McIlvaine...Supt. mot. pwr., Northern div..Buffalo
J. L. Cunningham..Supt. mot. power, W. Pa. div..Pittsburgh
E. B. DeVilbiss...Supt. mot. power, E. Ohio div..Pittsburgh
(formerly asst. eng. motive power, Pittsburgh)
W. Y. Cherry.....Supt. motive power, Lake div..Cleveland
(formerly master mech., Grand Rapids & Indiana, Grand Rapids)

NORTHWESTERN REGION

T. W. Demarest..Gen. supt. motive power......Chicago
(formerly supt. motive power, Northwest System, Pittsburgh)
O. C. Wright.....Supt. motive power, Ill. div...Ft. Wayne, Ind.
(formerly supt., Central System, Cambridge, O.)
O. P. Reese......Supt. mot. power, N. Ohio div..Toledo, O.

SOUTHWESTERN REGION

W. C. A. Henry...Gen. supt. motive power......St. Louis
(formerly supt. motive power, Columbus, O.)
J. E. Mechling....Supt. mot. power, Indiana div..Indianapolis
(formerly supt. motive power, St. Louis System, Indianapolis)
G. B. Fravel......Supt. mot. pwr., Cent. O. div..Columbus, O.
(formerly master mechanic, Southwest system, Columbus)

PURCHASING DEPARTMENT

Samuel Porcher...General purchasing agent.....Philadelphia

EASTERN REGION

Mont. Smith......Purchasing agent.............Philadelphia
H. A. Anderson...Asst. purchasing agent........Philadelphia
B. P. Philippe....Asst. purchasing agent........Philadelphia
D. T. Jones........Asst. to the purchasing agent..Philadelphia

CENTRAL REGION

W. G. Phelps.....Purchasing agent.............Pittsburgh
C. E. Walsh.......Asst. purchasing agent........Pittsburgh

NORTHWESTERN REGION

J. B. Thomas.....Purchasing agent.............Chicago
Henry Sullivan...Asst. purchasing agent........Chicago

SOUTHWESTERN REGION

C. R. Peddle......Purchasing agent.............St. Louis

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 163 Broadway, New York City. Convention May 4-7, Hotel Sherman, Chicago.

AMERICAN RAILROAD ASSOCIATION, SECTION III.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Convention, June 9-16, 1920, Atlantic City, N. J.

AMERICAN RAILROAD MASTER TINNERS' COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W Thirty-ninth St., New York.

AMERICAN STEEL TREATERS' SOCIETY.—W. H. Eisenman, 154 E. Erie St., Chicago.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—H. J. Smith, D. L. & W., Scranton, Pa.
J. C. Keene, Decatur, Ill.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago. Convention, May 24-27, 1920, Hotel Sherman, Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B.&M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

C. D. KINNEY, master mechanic on the Boyne City, Gaylord & Alpena, with office at Boyne City, Mich., has been promoted to superintendent of motive power, with the same headquarters. Mr. Kinney was born on August 25, 1876, at Conneaut, Ohio, and attended Conneaut High School. He took employment with the New York, Chicago & St. Louis in November, 1896, as a machinist apprentice, later working as a machinist on that road and on the Southern, the Central of Georgia and the Seaboard Air Line. From November, 1902, to April, 1908, he was general foreman of the Seaboard Air Line at Fernandina, Fla. He was then general foreman of the Kanawha & Michigan at Middleport, Ohio, and in May, 1910, was appointed master mechanic there. In November, 1912, he went to the Chicago & Alton, as general foreman at Roodhouse, Ill., remaining there until November, 1913, when he became enginehouse foreman of the Baltimore & Ohio at Pittsburgh, Pa., and later at Holloway, Ohio. From November, 1915, to October, 1916, he was master mechanic for the Robert Grace Contracting Company, Pittsburgh, Pa., and then went to the New York, Chicago & St. Louis as machine shop foreman at Conneaut, Ohio. In October, 1919, he became master mechanic of the Boyne City, Gaylord & Alpena at Boyne City, Mich., and in January, 1920, was appointed to his present position of superintendent of motive power.

C. D. Kinney

CHARLES BOND, mechanical engineer of the Erie, with office at Meadville, Pa., has been appointed general foreman of the centralizing plant, succeeding George W. Armstrong, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. E. BROGDEN, whose appointment as superintendent of the Waycross, Ga., shops of the Atlantic Coast Line was announced in the February issue, was born on March 10, 1876, at Sumter, S. C., and attended Clemson Agricultural & Mechanical College from 1893 to 1895. His entire railroad service has been with the Atlantic Coast Line, having entered its employ as a machinist apprentice in 1896. In 1903 he was promoted to the position of roundhouse foreman at Florence, S. C., and was appointed general foreman on April 1, 1904. On April 1, 1906, he was transferred to Savannah, Ga., and about a year later to Montgomery, Ala. On January 1, 1918, he was appointed master mechanic at Montgomery, and on August 1, 1918, was transferred to Waycross, Ga., as master mechanic of the Waycross and Savannah districts.

C. H. CHAMBERS, road foreman of engines on the Atchison, Topeka & Santa Fe, has been appointed assistant air

brake instructor, with jurisdiction over the Western, Arkansas River, Colorado and New Mexico divisions, with headquarters at La Junta, Colo., succeeding M. O. Davis, who has resigned to accept a position with the Westinghouse Air Brake Company at Topeka, Kan.

R. R. Herrick has been appointed master mechanic of the Detroit, Bay City & Western and the Port Huron Southern at Bay City, Mich.

I. B. Irvin, general foreman of the Pittsburgh, Shawmut & Northern at Angelica, N. Y., has been appointed master mechanic without change of headquarters, and the position of general foreman has been abolished.

Louis Metzger, chief inspector at the Jersey City, N. J., roundhouse of the Erie, has been promoted to the position of roundhouse foreman.

W. N. Mitchell, formerly master car builder on the Missouri, Kansas & Texas, and who for the past five years has been engaged in government valuation work, has been appointed superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Denison, Tex.

F. H. Moore has been appointed assistant master mechanic of the Maritime district of the Canadian National Railways, with headquarters at Moncton, N. B.

Arthur L. Robinson, assistant to the general superintendent of the Wabash, with headquarters at St. Louis, Mo., has been appointed to a newly created position in which he will supervise the adjustment of controversies between the management and the employees.

George Searles has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, with headquarters at Needles, Cal., succeeding Charles Raitt, assigned to other duties.

J. P. Stewart has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe, with jurisdiction over the Second and Third districts of the New Mexico division, with headquarters at Las Vegas, N. M., succeeding C. H. Chambers.

SHOP AND ENGINEHOUSE

James M. Coble has been appointed shop superintendent of the Buffalo, Rochester & Pittsburgh at Rikers, Pa., succeeding W. W. Scott, resigned.

OBITUARY

George Lindsay, formerly master mechanic of the Evansville, Ind., shops of the Evansville & Terre Haute, died in that city on January 24, aged 69 years.

Edward P. Ripley, chairman of the board of directors and formerly president of the Atchison, Topeka & Santa Fe, and one of the greatest railroad executives America has produced, died in Santa Barbara, Cal., on February 4, as the result of complications following an operation performed several months ago. Mr. Ripley was born at Dorchester, Mass., on October 30, 1845. He began railway work in 1868 as contracting agent for the Star Union Line at Boston, Mass. From October, 1870, to 1872, he was clerk to the general eastern agent of the Chicago, Burlington & Quincy, and from the latter date to 1875 he was New England agent. He then became general eastern agent, and on June 15, 1878, was made general freight agent. He held the latter position until 1887, when he was appointed traffic manager, and the following year he was promoted to general manager of the Burlington. In August, 1890, he was chosen third vice-president of the Chicago, Milwaukee & St. Paul, which position he held until he became president of the Santa Fe on January 1, 1896.

SUPPLY TRADE NOTES

The Conley Car Company, Pittsburgh, Pa., has changed its name to the Conley Tank Car Company.

E. C. Middleton has been appointed advertising manager of the Colburn Machine Tool Company, Franklin, Pa.

Theodore L. Dodd & Co., Chicago, have been appointed district sales representatives for the Titusville Forge Company, Titusville, Pa.

Samuel M. Vauclain, president of the Baldwin Locomotive Works, Philadelphia, has returned to this country after a brief visit to Europe.

C. E. Bransfield, foreman for the Standard Car Construction Company, Masury, Ohio, has been promoted to general superintendent.

The capital stock of the Highland Iron & Steel Company, Terre Haute, Ind., has been purchased by the American Chain Company, Inc., New York.

Frederick W. Renshaw, president of the Globe Seamless Steel Tubes Company, Chicago, died on February 1 at his home in Evanston, Ill., at the age of 39 years.

Donald S. Linton has joined the Warner & Swasey Company, Cleveland, Ohio, having formerly been connected with the Pratt & Whitney Company, Hartford, Conn.

Frank A. Turner, chief engineer of the Becker Milling Machine Company, Hyde Park, Mass., has become chief engineer of the Flexible Automotive Tire Company, Boston.

Charles E. Hildreth, president and general manager of the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., has been elected president of the Worcester chamber of commerce.

Harold M. Davis, manager of the advertising department of the Sprague Electric Works of the General Electric Company, New York, died at his home in Brooklyn on February 9, 1920.

Arnold J. Burke, for 16 years connected with the United States armory in Springfield, Mass., has been appointed employment manager of the Greenfield Tap & Die Corporation, Greenfield, Mass.

George W. Diehl, president of the Cincinnati Shaper Company, Cincinnati, Ohio, has sailed for England and France, to establish branches through which the company's foreign business will be handled.

G. C. Cook, general sales manager of the Warner & Swasey Company, has left for a five weeks' trip through the South and to the Pacific coast. He expects to visit about 50 cities and towns before returning.

The Gardner-Bryan Company, Cleveland, Ohio, has been appointed special representative in Ohio, Indiana and Western Pennsylvania for the Precision and Thread Grinder Manufacturing Company, Philadelphia, Pa.

C. B. Ferry, vice-president of the Chicago, Milwaukee & St. Paul, has been elected a director of the Associated Welding Companies, Inc., New York, a corporation formed recently by thirteen electric welding companies.

William R. Mau, general superintendent of the Rich Tool Company, Chicago, has been appointed Chicago district manager of the Vanadium-Alloys Steel Company, Pittsburgh, Pa., with offices at 566 West Randolph street, Chicago.

F. H. Maple, superintendent of the Point St. Charles (Que.) plant of the Canadian Steel Foundries, Ltd., Montreal, Que., has been appointed foundry superintendent of the American Steel Foundries' plant at Alliance, Ohio.

The Sherritt & Stoer Company, Inc., Philadelphia, Pa., announces the opening of new offices, storeroom and warehouse at 2006-8 Market street, where it will maintain a permanent exhibition of machine tools, railway and machine shop equipment.

The Westinghouse Electric & Manufacturing Company has filed plans for the erection of a machine shop, 1,000 ft. long by 100 ft. wide, on Page boulevard, Springfield, Mass., to cost $250,000. The building will be of brick, concrete and steel, of the saw-tooth type.

William R. Gummere, who for a number of years represented the Independent Pneumatic Tool Company, of Chicago, in Cleveland, Ohio, has again become affiliated with that company at the Pittsburgh branch, which is under the management of Harry F. Finney.

J. A. McLennan, general superintendent of the Link-Belt Company, Philadelphia, Pa., has resigned to become general manager of the McDonough Manufacturing Company, Eau Claire, Wis., which has recently been reorganized and is now manufacturing machine tools.

Howard C. Rose, 827 Ford building, Detroit, representative of the Ingersoll Milling Machine Company, Rockford, Ill., and the Foote-Burt Machine Company, Cleveland, will make an extended tour through Europe in the interests of these companies, for purposes of trade investigation.

Alexander MacDonald Graver, vice-president of the Graver Corporation, East Chicago, Ind., died at his home in Chicago on January 31. Mr. Graver was one of five brothers who control the Graver Corporation, formerly the Wm. Graver Tank Works. He was born at Pittsburgh, Pa., on May 15, 1883, and was educated at the University of Michigan, from which institution he graduated in 1905. He then entered the engineering department of the Wm. Graver Tank Works, where he had charge of the electrical and steam equipment and remodeled the company's manufacturing plant. In 1908 he entered the purchasing department and soon after assumed charge of the purchase of steel plates. From 1910 to the time of his death, Mr. Graver was identified with the sales department of the organization and for the past two years has been virtually sales manager, although holding the title of vice-president of the organization.

A. M. Graver

L. R. Meisenhelter has been appointed special representative of the Houston, Stanwood & Gamble Company, Cincinnati, Ohio, and will devote his entire time to the sale of this company's line of lathes. Mr. Meisenhelter has disposed of his interest in the L. R. Meisenhelter Machinery Company.

The Plant Engineering & Equipment Company, Inc., New York, manufacturers of the Corliss valve steam trap and other power and heating specialties, announces the opening of an office at 282 South Ferry street, Newark, N. J. M. Wm. Ehrlich has been made New Jersey manager, with a sub-office at Lyndhurst, N. J.

Oscar Nordstrom, formerly district manager of the Norton Company, Worcester, Mass., with headquarters in Cincinnati, is at present taking a training course in the machine division at the Worcester works. H. W. Lehman, Cleveland, has been transferred to Cincinnati to take over the former duties of Mr. Nordstrom.

E. E. Griest, notice of whose appointment as general superintendent of the Chicago Railway Equipment Company, Chicago, appeared in the January issue, was born at Zanesville, Ohio, on November 28, 1882. He entered railway service in 1899 as a clerk in the auditors' office of the Cleveland & Marietta at Cambridge, Ohio. In 1900 he entered the employ of the Pittsburgh, Cincinnati, Chicago & St. Louis as an apprentice machinist in the Columbus (Ohio) shops, remaining in this capacity and later as a machinist until November, 1904, when he entered Purdue University, graduating in 1907. After some time spent in Alaska, he returned to the United States in 1907 as a designer in the engineering department of the Crucible Steel Company of America, Pittsburgh, Pa. In 1908 he was appointed foreman in the Hornell (N. Y.) shops of the Erie and later in the same year he was appointed assistant machine shop foreman in the Fort Wayne (Ind.) shops of the Pennsylvania Lines West. On March 15, 1909, he was promoted to assistant master mechanic, with the same headquarters, and in January, 1915, he was promoted to master mechanic. He retained this position until 1918, when he resigned to become connected with the Chicago Railway Equipment Company, with headquarters at Chicago. In September, 1918, he was transferred to Detroit, Mich, remaining there until his recent promotion.

E. E. Griest

Frank R. Bacon, president of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has been elected chairman of a new organization in Milwaukee known as the American Constitutional League, the activities of which will be confined solely to Americanization work and which will embrace all forms of education and publicity in favor of Americanization.

F. Rodger Imhoff, New England representative of the Precision & Thread Grinder Manufacturing Company, Philadelphia, has been appointed field engineer, with headquarters in Detroit, covering the entire country in the interest of the multi-graduated precision grinder. Mr. Imhoff is an expert in thread grinding and has written many papers on that subject.

Arthur G. Henry, metallurgist for the Illinois Tool Works and secretary of the American Steel Treaters' Society since its organization in September, 1918, has resigned from both offices to become special representative for the Vanadium Alloys Steel Company, Latrobe, Pa., with offices at 566 W. Randolph street, Chicago. Mr. Henry has been succeeded

on the board of directors of the American Steel Treaters' Society by W. H. Eisenman, business manager of the society, who in addition also succeds him as secretary, combining the two offices with the title of executive secretary.

The Booth Electric Furnace Company, Chicago, announces the opening of two new sales offices in addition to the regular district offices already established. One is at Detroit, 805 Hammond building, and is in charge of M. A. Beltaire, Jr.; the other is at Birmingham, Ala., located in the Brown and Marx building, and is in charge of Cassman & Cunningham.

The Imperial Belting Company, Chicago, has opened a special railroad sales department under the direction of A. G. Pickett as general manager and the following have been appointed sales engineers: Edward H. Willard, David L. Jennings and William D. Otter, all formerly with the H. W. Johns-Manville Company; William G. Willcoxen, formerly associated with the Boss Nut Company, Chicago, and Edward A. Woodworth, formerly secretary of the Committee on Standards for Locomotives and Cars of the United States Railroad Administration. A new office has been opened in the Merchants' National Bank building, St. Paul, Minn., in charge of Blake C. Hooper. A. G. Pickett was born at New London, Mo., on July 12, 1888. In 1911 he became connected with the sales department of the National Refining Company, Hannibal, Mo. Later in the same year he was appointed special power plant representative for the H. W. Johns-Manville Company at New York. On January 1, 1916, he was promoted to assistant manager of the power specialties department and in 1917 was promoted to manager of that department, which position he retained until August, 1919, when he resigned to become connected with the sales department of the Imperial Belting Company.


A. G. Pickett

The Hauck Manufacturing Company, Brooklyn, N. Y., announces the removal of the Pittsburgh office of the Hauck Burner Service Station from 2930 Penn avenue to 105 Wood street. The Boston and Cleveland service stations have also been moved to larger quarters, the former from 70 High street to 149 Berkeley street, and the Cleveland office from 2114 Superior viaduct to 1106 Walnut avenue.

A. A. Blue has been placed in charge of the heat treating department of the Duff Manufacturing Company, Pittsburgh, Pa. Mr. Blue is a graduate of the chemical engineering department of Cornell University. For two years he was connected with the Midvale Steel Company in the heat treating department, and during the war served as assistant superintendent of heat treating and forge shop in the gun plant of the Watertown arsenal.

The American Chain Company, Bridgeport, Conn., has purchased the control of the Page Steel & Wire Company, with mills at Monessen, Pa., and Adrian, Mich., and the business will be continued as heretofore. The new officers elected under the reorganization of the company are Walter B. Lashar, president; William T. Morris, vice-president; Wilmot F. Wheeler, treasurer; John E. Carr, assistant treasurer, and William M. Wheeler, secretary. E. C. Sattley, general manager of the Page Steel & Wire Company, will continue in that capacity with office in Pittsburgh, Pa.

C. N. Kell, has been appointed assistant to the general manager of the forge department of the Duff Manufacturing Company, Pittsburgh, Pa., manufacturer of lifting jacks. For the last eight months he has been assistant to the general superintendent of this company in charge of efficiency work. Mr. Kell designed the equipment of the Rock Island arsenal for testing the recoil mechanism of the French 75-mm. gun. His previous experience included work as mechanical engineer with the Mandel Corporation of Chicago, and an assistant superintendent of the Denny Tractor Company, Cedar Rapids, Iowa.

F. J. Mawby, who was formerly connected with the sales force of Manning, Maxwell & Moore, Inc., and located at the New York office for a number of years, severed his connection with that company on February 1, 1920, and is now a member of the sales organization of the Cincinnati Shaper Company and the Cincinnati Gear Cutting Machine Company, Cincinnati, Ohio. During the war Mr. Mawby did a great deal of engineering work in connection with equipping shops for the manufacture of ammunition, guns and gun carriages for both the United States and foreign governments, and was responsible for the development of a number of special machines for the rapid production of time and high explosive fuses.

B. G. Koether has been appointed vice-president of the Hyatt Roller Bearing Company, Detroit, Mich., in entire charge of the company's sales and advertising departments. At present located at Detroit, Mr. Koether will leave in a short time for Harrison, N. J., there to establish headquarters and take up his new duties. Mr. Koether entered the employ of the Hyatt Roller Bearing Company 18 years ago as accountant and in a short time was promoted to the position of purchasing agent. He was made assistant sales manager at Harrison, N. J., and in 1910 went to Detroit to assume the duties of sales manager. Later he became the head of the motor bearings division and for several years past has been a director of the company. Mr. Koether is a member of the Detroit Board of Commerce and the Detroit Section of the Society of Automotive Engineers.


B. G. Koether

The Williams-Hayward Company has been incorporated at Chicago for the manufacture of varnishes, enamels and paint specialties. LeRoy A. Williams, for 21 years associated with the railroad department of the Flood & Conklin Company, Newark, N. J., is president of the new company and Oscar C. Hayward, for 18 years manager of railroad sales of the Tousey Varnish Company, Chicago, is vice-president. Otto Woldt has been appointed head of the manufacturing department and Max Huhnholz superintendent of the enamel and paint specialties department. The company has purchased a modern varnish factory with a capacity of approximately 500,000 gal. of varnish annually, to which complete mills for the manufacture of enamels and

paint specialties have been added. The main offices and plant are located at 2526 West Van Buren street, Chicago.

Westinghouse Air Brake Company

Joseph R. Ellicott on January 1, 1920, retired as eastern manager of the Westinghouse Air Brake Company, but has been retained by the company in a consulting capacity. He has been succeeded as eastern manager by Charles R. Ellicott, as briefly noted in the January issue. Mr. Ellicott was born in Chicago on November 13, 1881. He received his early education in the public schools of New York, and was graduated from Yale-Sheffield School in 1902. The same year he entered the employ of the Westinghouse Air Brake Company, at Wilmerding, Pa., as special apprentice. After serving two years in the engineering and commercial departments, he was made representative in the New York office, covering both commercial and engineering work. In 1913 he was made assistant eastern manager of the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company. On January 1, 1920, Mr. Ellicott was made eastern manager of both companies.

Robert Burgess has been promoted to southeastern manager, with office in Washington, D. C. He was born in New Haven, Conn., and attended public school there, graduating from grammar and high schools. He began railway service with the Louisville & Nashville under the late Pulaski Leeds as machinist apprentice. On completion of his apprenticeship course he continued with the company in the various capacities of air brake repairman, roundhouse foreman, locomotive fireman and engineer, and general air brake inspector. He joined the Westinghouse Air Brake Company organization in 1893 as assistant instructor in the company's air brake instruction car. In 1896 he was assigned to the southern district, with headquarters at Atlanta, Ga., and for several years at Richmond, Va. He has since that time represented the company continuously in that district as mechanical inspector and commercial representative.

Carl H. Beck has been appointed assistant eastern manager at New York. He was born in Butler, Pa., and was graduated with the class of 1905 in mechanical engineering from Pennsylvania State College. The same year he entered the special apprenticeship course prescribed by the Westinghouse Air Brake Company. He was a specialist on the introduction of the ET locomotive brake equipment, personally superintending the installation of this equipment on some of the first locomotives to be so equipped at the Baldwin and American Locomotive Works. In 1910 he was made commercial representative in the electric railway field, becoming prominently identified in the development and introduction of the safety car equipment. Mr. Beck's study of electric railway operation has made him an authority on transportation problems.

John B. Wright has been promoted to assistant district manager in charge of the Pittsburgh office district. He was born on July 27, 1857, in Pleasantville, Pa., and received his education in the public schools there and at Central State Normal School, Lock Haven, Pa., graduating in 1896. He worked for about 18 months with the Cambria Steel Company, at Johnstown, Pa. In February, 1899, he entered the service of the Westinghouse Air Brake Company, at Wilmerding, Pa., as a clerk in the engineering department. After serving for some time as chief clerk in that department, he was transferred to the general office in charge of engineering correspondence, and later was made assistant to the vice-president. In May, 1919, he was appointed assistant southeastern manager.

A. K. Hohmyer has been promoted to the position of assistant western manager, Chicago, Ill. He was born in Pittsburgh, Pa., and attended the public schools of that city. In February, 1901, he started to work for the Westinghouse Air Brake Company, in the general office, as office boy. He passed rapidly and successively to the order department, engineering department, and other departments until February, 1909, when he was traneferred to the Chicago office as office manager. He remained in that position until 1913, when he was appointed commercial representative. He continued to work in that capacity until January 1, 1920, the time of his promotion to assistant western manager.

William G. Kaylor has been promoted to representative of the newly organized export department of the Westinghouse Air Brake Company, with headquarters in New York. He was born in Indianapolis, Ind., attending public school there and graduating from the Manual Training High School. He graduated from Purdue University in 1905, and entered the employ of the Westinghouse Air Brake Company at Wilmerding, Pa., as a special apprentice. The first year he served in the experimental and engineering departments, and the following year in field work, covering the equipment of electric locomotives for the New York Central at the various building plants throughout the east. He also installed the first air brake equipment on the all-steel passenger cars in interurban New York City service. He acted as mechanical expert in connection with the introduction of electric service on the main lines of both the New York Central and New York, New Haven & Hartford railroads. After serving as assistant for several months to the resident engineer, he became actively engaged in November, 1911, in commercial work, specializing in the traction brake field.


C. R. Ellicott


Robert Burgess


F. H. Parke

F. H. Parke, resident engineer, southeastern district, has been promoted to general engineer, with office at Pittsburgh, Pa. He was born in 1869 at Waterloo, N. Y., and was educated in the public schools at Binghamton, N. Y., and St. John's School, Manlius, where he prepared for a course at Cornell University. He was graduated from Cornell in mechanical engineering in 1892, and immediately entered the service of the Westinghouse Machine Company at Pittsburgh, Pa., first as draftsman and afterwards as engineer of tests. In 1898 he took service with the Westinghouse Air Brake Company, spending the first four years in Petrograd, assisting in the installation of the Westinghouse Air Brake plant being erected there to handle the Russian railway business. Returning to the home office at Wilmerding, Pa., he was given charge of the publicity department and afterwards was made industrial engineer, in which capacity he served until 1911. He was then made resident engineer of the southeastern district.

T. W. Newburn, assistant resident engineer, southern district, at Pittsburgh, has been promoted to district engineer of the southeastern district, with office at Washington, D. C. Mr. Newburn was born near Hoopston, Ill., and received his early education in the country schools and at Greer College. He was graduated from Purdue University with the 1902 class in mechanical engineering, and immediately entered the service of the Cambria Steel Company, Johnstown, Pa. In August, 1902, he entered the employ of the Westinghouse Air Brake Company, being assigned duties in the mechanical and engineering departments of its Wilmerding factory. He was connected later with the Cleveland office, then with the Columbus office as mechanical expert in connection with electric railway brakes. In 1914 he was assigned to the Pittsburgh office as assistant resident engineer, where he leaves to take up his new duties.

Joseph H. Woods of the commercial engineering department at Wilmerding has been promoted to engineer of the newly arranged export department. He was born in February, 1886, at Hamilton, Ont. After graduating from the public schools and Hamilton Collegiate, he was employed as an apprentice in a machine shop for three years, and then entered the mechanical drawing room of the Canadian Westinghouse Company, Ltd. In 1908 he was transferred to the air brake department. The following year he entered the engineering test department, and in 1911 was appointed assistant engineer of tests. In 1915 he was transferred temporarily to New Jersey as general foreman of the Air Brake Company's shrapnel loading plant. On completion of the shell loading work in 1916 he returned to Wilmerding to take up duties in the general office division of the engineering department.

Joseph C. McCune, special engineer at Wilmerding, is now assistant to the eastern district engineer, with office in New York. He was born in Brilliant, Ohio, in 1890. He attended the high school at Steubenville, Ohio, and in 1906 entered Washington and Jefferson College, taking preparatory work for one year. He graduated from Cornell University with the class of 1911, receiving the degree of mechanical engineer. He entered the employ of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., and later served in the traffic department of the Pittsburgh Railway Company. In 1913 he joined the Westinghouse Air Brake Company as assistant to the chief engineer, Dr. Walter V. Turner. In 1915 he was transferred to the New York office as mechanical expert, charged with the development and satisfactory operation of the new air brake equipment then being applied to the subways of Greater New York. In 1916 he served for five months at the Mexican border with the 7th Regiment, N. Y. N. G. Returning from this service, he was commissioned first lieutenant in the Engineer Officers' Reserve Corps, and upon the outbreak of the war with Germany was ordered to active duty. He was an engineering instructor at the 1st, 2d and 3d Officers' Training Camps, and in May, 1918, was assigned to the 603d Engineers, going overseas with this organization and remaining abroad for ten months. Returning to this country, he re-entered the employ of the Westinghouse Air Brake Company as special engineer at Wilmerding.

The Western Electric Company, Inc., 195 Broadway, New York, has reorganized its railroad representative staff under the direction of George H. Porter, manager of the railroad department, as follows: The Western district representatives are: J. P. Casey, St. Louis, Mo.; W. J. Schott, Kansas City, Mo.; George Chestnut, Houston, Tex.; G. N. Hoffman, Salt Lake City, Utah; W. H. Laufenberg, Denver, Colo.; J. E. Coad, Dallas, Tex. Those for the Coast district are: I. A. Shorono, Seattle, Wash.; J. G. Loomer, Los Angeles, Cal.; H. A. Case, San Francisco, Cal.; Jack F. Ryan, Portland, Ore.; J. H. Kelley, Tacoma, Wash.; C. A. Martin, Spokane, Wash. Central district: Otto Danielson, Chicago; E. B. Elliott, Chicago; A. J. McCall, Omaha, Neb.; Tom Wheatley, Cleveland, Ohio; R. D. Eves, Cincinnati, Ohio; W. H. McGann, Cincinnati, Ohio; R. W. Tenbroeck, Toledo, Ohio; C. E. Roberts, Indianapolis, Ind.; W. H. Tompkins, Milwaukee, Wis.; E. B. Denison, Minneapolis, Minn.; G. E. Brown, Duluth, Minn.; A. W. Hillis, Detroit, Mich.; A. Schwenck, Grand Rapids, Mich. Eastern district: Oscar Lepper, Pittsburgh, Pa.; A. B. Thomson, New York; Charles R. Wharton, Philadelphia, Pa.; Fred Jaeger, Philadelphia, Pa.; James Stuard, Philadelphia, Pa.; E. R. Morgan, Boston, Mass. Southern district: William Lancaster, Richmond, Va.; H. B. Stanton, Savannah, Ga.; W. R. Phillips, Jacksonville, Fla.; J. W. Smith, Atlanta, Ga. A. L. Frankenberger remains at St. Paul, Minn., and Sidney Greenfeld at Baltimore, Md.

Arthur Elliot Allen has been appointed district manager at New York for the Westinghouse Electric & Manufacturing Company, to succeed Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Company. Mr. Allen is a native of Toronto, Canada, and received his education in England and also in this country. In June, 1902, he entered the employ of the Westinghouse Electric & Manufacturing Company at its Newark works, subsequently being placed in charge of the test department, where he remained until 1910. In that year Mr. Allen was loaned by the management of the company to the International Electric Protection Company, for which company he acted as chief engineer. After completing that temporary work, he returned to the employ of the Westinghouse company, and on December 1, 1915, Mr. Allen was appointed manager of the supply division of the New York office, which position he retained until he joined the Canadian Overseas Forces in October, 1917. After being honorably discharged from the army he returned to the New York office of the Westinghouse company as executive assistant to the manager, from which position he was promoted to manager.

A. E. Allen

TRADE PUBLICATIONS

Asbestos.—In the December issue of the *Railway Mechanical Engineer* there appeared a short review of the first number of Asbestos, a monthly magazine, in which it was stated that the publisher is the Magnesia Association of America. This statement is erroneous, as the booklet is published by Secretarial Service, 721 Bulletin building, Philadelphia, Pa.

Electric Cranes.—A bulletin entitled Lane Electric Cranes, has been issued by N. B. Payne & Co., 25 Church street, New York, agents for cranes manufactured by the Lane Manufacturing Company, Montpelier, Vt. The bulletin fully illustrates and describes several styles of cranes in which steel girders or heavy timbers of yellow pine are used, and contains a complete set of specifications.

Furnace Burners. — Bulletin No. 119 of the Hauck Manufacturing Company, Brooklyn, N. Y., describes in detail the many different types of oil burners manufactured by this company and illustrates practical applications of the burners to various types of furnaces. In addition, a number of sketches are included, suggesting other ways of applying Hauck burners, and throughout the book are given results of tests, prices and service data.

Auxiliary Devices Governor.—Instructions for the installation and care of the auxiliary devices governor have been published for distribution by the Westinghouse Air Brake Company, in a 12-page booklet bound with stiff covers and designated as General Instructions No. 2360. The construction and operation of the governor is described and is supplemented by sketches with the parts numbered and named. Instructions are also given for properly adjusting the pressure.

Boiler Feed Control.—A 24-page booklet entitled Saving Fuel Automatically and Scientifically in the Boiler Room has been published by the Northern Equipment Company, Erie, Pa. It is based upon matter that was prepared for the United States Fuel Administration during the war and compares hand and mechanical feeding with mechanical regulation, as performed by the Copes regulator, being illustrated with a number of charts and diagrams to emphasize the value of scientific control.

Brake Rod Jaw. — The Schaefer Equipment Company, Pittsburgh, Pa., describes and illustrates, in a four-page pamphlet, the Schaefer drop-forged brake rod jaw for attachment to brake rods. The method of applying the jaw is simple and is illustrated. It is claimed that the jaw may be removed and reattached without any danger from failure and that it may be applied and reapplied without loss. The pamphlet also shows the results of pulling tests on six different jaws fastened on 7/8-in. brake rods, which were made at the Pittsburgh Testing Laboratory.

Valves.—Catalogue and price list No. 10 of Nelson valves has been issued by the manufacturers, the Nelson Valve Company, Philadelphia, Pa. The book contains 156 pages, 5 in. by 7½ in., and is bound in cloth. It is divided into three parts, devoted respectively to bronze, iron and steel valves, with an introduction describing the general features of the design and service rendered. The valves are made in gate, globe check and non-return patterns for practically every class of service found in power plant work, etc. The book contains numerous illustrations and the data is conveniently arranged.

Draft Gears—Force and Its Applied Principles, is the title of a 28-page booklet, bound in stiff paper covers, which has just been issued by the Union Draft Gear Company, Chicago. The booklet explains concisely and non-technically the elementary relationship of force and motion, defining the terms used. How these principles apply to the operation of the draft gear is then set forth and the booklet concludes with a discussion of draft gear capacity and the essentials of draft gear testing. A table for the conversion of miles per hour into height of fall in feet, for use in calculating the energy in moving cars for speeds from 1 to 10 miles per hour by half mile intervals, is included.

Industrial Management.—L. V. Estes, Incorporated, industrial engineers, Chicago, have published a small booklet entitled Human Relations in Industry, for the purpose of pointing out the underlying principles of personal relations and industrial management that are essential to industrial harmony and maximum production. It contains a statement showing the trend of present conditions and the need for definite action by employers, and outlines in a general way the procedure necessary for putting in effect plans tending toward a betterment of human relations in industry.

Steel Pipe. — National Bulletin No. 24A has been issued by the National Tube Company, Pittsburgh, Pa., and shows graphically the remarkable growth of the steel pipe industry from 1888 to the present time. The chart indicates a decrease in the production of wrought iron pipe during this period. Quotations are given from the editorial columns of three current periodicals in the iron field to show the reasons for the popularity of steel pipe and its probable permanence. Included in the bulletin is a chart showing the relative production of wrought iron and steel skelp from 1888 to 1918.

Drop Forgings.—J. H. Williams & Co., Brooklyn, N. Y., manufacturers of Superior drop forgings and drop-forged tools, have issued the seventeenth edition of their catalogue, containing 160 pages, 4 in. by 6 in., fully illustrating and describing their standard stock specialties. These include new lines of "Agrippa" set screw pattern turning tool holders, "Agrippa" boring tool posts, "Vulcan" forged-cutter tool holders, and several new sets of drop-forged wrenches. The book also contains a description of the drop-forging process in simple, non-technical style for the benefit of those not conversant with its details.

Opportunities for Technical Graduates.—Opportunities for technical garduates are very thoroughly explained in an illustrated pamphlet bearing that title, recently issued by the Westinghouse Electric & Manufacturing Company. This booklet describes, in considerable detail, the plan which has been developed by this company for the training of the graduates of technical schools at all of its various works. In the booklet is included a list of prominent Westinghouse men who originally entered the company as graduate students, as well as a complete list of schools from which over 5,000 students have entered the employ of the company.

Insulation Products.—The Franklin Manufacturing Company, Franklin, Pa., has issued a 77-page catalogue entitled Heat Insulations. This catalogue contains brief descriptions of the company's insulation products, including 85 per cent magnesia pipe covering, railroad special pipe covering, Franklin carlining, asbestos millboard, wool felt covering, etc. Packing and shipping directions are included. The back part of the catalogue contains considerable engineering information in the form of tables and data to be used in the solution of heat insulation problems. Instructions for the use of these tables are given and several concrete examples are worked out.

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Electrically Driven Portable Tools

Portable tools driven by compressed air are in such general use in railroad shops that the possibility of securing better results with a device of some other type is seldom considered. In view of the high cost of pneumatic power and the serious leakage that exists in the majority of air lines, it is quite probable that for many uses electric drills would prove more economical than air drills. The most important advantage of electric tools aside from the saving in power is the substitution of wires for piping and hose. The power lines can be extended very readily, power losses are decreased, the wires are easily handled and the expense of installation and upkeep compared with the cost of maintaining air pipe lines and pneumatic hose is considerably less. The even turning moment and absence of vibration in the tools are also important advantages. On the other hand, an electrically driven tool is liable to burn out if the motor stalls, and for that reason ample capacity must be provided or automatic reclosing circuit breakers must be used in each circuit.

Some roads have applied electric tools here and there through the shop, but very often the conditions under which they were used have been so unfavorable that the tools did not have a chance to show their worth. Much of the prejudice against electric tools that exists in some shops today is due to the improper application of universal motors. This type of motor was introduced to meet the demand for machines that could be used with either direct or alternating current, but is not well adapted for heavy portable tools. Universal motors should never be used for reaming, and on machines used for drilling they should be limited to sizes not larger than ½ in. For general work, series motors for direct current, or induction motors with high slip for alternating current are most suitable. These types possess characteristics that make them more satisfactory (for many purposes) than air tools.

Scientific Tool Hardening

In railway repair shop practice the experienced tool dresser is so important that he might almost be said to be invaluable. Almost every repair shop has developed at least one tool dresser who by years of experience has become expert in hardening hand chisels, cape chisels, beading tools and all sorts of small tools. Given a known steel plus a knowledge of the work to be done, and it is surprising how satisfactory and reliable a tool can be turned out—sometimes. The difficulty is that the tool dresser must depend upon his eyesight to estimate temperatures and upon rule of thumb methods to harden the tools. His equipment consists of a forge and anvil; sometimes a small power hammer and suitable cooling tanks are available, but too often there is no accurate temperature recorder.

While tool dressers of the type referred to do the best they can with the equipment provided and often succeed in producing a tool which is not only strong but holds its cutting edge under severe duty, the opposite usually is true. A uniform product is impossible, and if one tool is good the next is likely to be poor. It is practically useless to buy high-grade steel and then profit by only part of its good qualities because of improper and non-uniform methods of hardening. The solution of the problem is to provide modern, up-to-date equipment, including some type of muffle furnace arranged for accurate temperature control, an indicating pyrometer to gage the temperatures and suitable oil, lead and brine baths for drawing. In any shop of medium or even small size the saving effected by installing such equipment will be found more than sufficient to pay the carrying charges on the investment involved.

To prove the relative merits of scientific heat treatment of steel versus guesswork methods, an extensive series of tests was made recently in a large, well-equipped shop. A stand-

ard, high-grade tool steel was used and similar tools, hardened by the two processes, were tested under actual working conditions. A mixture of 75 per cent lead and 25 per cent tin with a melting point of approximately 450 deg. F. was used for the lead bath, the bath being well covered with charcoal to prevent oxidation and to keep the lead from adhering to the tools. In every case 24 identical tools were selected. Twelve were heated in furnaces equipped with indicating pyrometers and the other 12 were heated in furnaces without pyrometers, or in forges, the temperatures being estimated by the operator. The same man did the heating, hardening and tempering of both lots of tools.

Twelve hand chisels were heated in a lead furnace to 1,440 deg. F., quenched in a 10 per cent brine solution and drawn to a deep blue (580 deg. F.) in the lead alloy, checking the temper in oil. The chisel heads were reheated from 1,300 to 1,350 deg. F. to relieve forging strains. An old locomotive axle was used for testing purposes and 3,000 blows were struck per chisel with a 1½-lb. hammer. At the conclusion of the test the cutting ends of the chisels showed no signs of wear, while the chisel heads were mashed down ½ in. Of the 12 tools made without the pyrometer three showed fire cracks, four finished the test and the remainder broke in service because of irregular temperature in heating and forging.

In the next test 12 pneumatic beading tools were heated in a lead bath to 1,440 deg. F. The working or boot ends were drawn to 470 deg. F. in oil, which is equivalent to a dark straw color; and the shank temper was drawn to 520 deg. F. in oil, which is equivalent to a purple color. Each end of the tool was hardened separately and then drawn to the proper degree to insure a tough center. The quenching was done in a 10 per cent brine solution, at about 60 deg. F. The average service life was 2,850 flues per tool and no tools were broken. The second set of 12 beading tools, on the other hand, produced only 863 flues. Three tools broke in the shank, two at the radius of the boot ends and the fractures showed a coarse structure because the temperature limit had been exceeded.

These tests demonstrate conclusively the large increase in efficiency possible by the use of definite scientific methods of heat treating and hardening. They explain why the more progressive steel companies are co-operating with their customers in installing modern appliances for heat treating steel. The results also furnish the strongest evidence why such equipment is needed in every shop.

Optimism is the Watchword

The paper presented at the March meeting of the Central Railway Club and the discussion which followed it will bear careful reading, especially by those who are inclined to be pessimistic about the labor situation. Reviewing casually the outstanding developments of the last few months, there seems to be ground for pessimism. In many shops production is near the low mark, controversies brought about by the national agreement are still unsettled, and the shop organizations are now asking for an advance in wages which would add still further to the cost of maintaining equipment.

Despite these facts, the men who spoke at Buffalo were optimistic regarding the solution of the present labor problem. The basis for their confidence was evidently a firm belief in the ultimate good sense of the American workingman. Labor has suffered from poor leadership and some have been misled by radicals who have tried to persuade the men that they could get something for nothing. The discussion of economic problems in the daily press has had its effect, however, and today the average workingman realizes that his share of the necessities and luxuries of life depends almost wholly on how much is produced. With this fact generally recognized by the men there is little likelihood that the railroad officers will find any opposition to increased production if the workers are appealed to in the proper spirit. Further education may be required before the situation becomes satisfactory, but the present trend of events is at least encouraging.

Putting It Up to the Men

Granting that the average workman realizes that high production is necessary, it may be well to inquire what is being done to interest the men in increased shop output. The officers in charge of the shops are always greatly concerned when there is a falling off of production. The supervisors must obtain results by influencing the men in their organization. The lack of personal contact makes it hard for those in charge to pass their own spirit on to the men, but there are methods of arousing interest and getting results. It is natural for men to take pride in the organization of which they are a part. If the matter of increased production is approached in the same spirit as a baseball contest, if the natural desire to excel in any branch of endeavor can be brought to the fore, the officers can put the matter of increased output up to the men and there will be no question about the result. To apply this principle successfully a fair measure of shop efficiency and accurate records are essential. No one will take a keen interest in a game if the rules are unfair or if the score is not kept correctly. The cost of repairs is not a fair measure at the present time, but the man-hours per unit of work furnish a satisfactory means of gaging shop efficiency. Charts or diagrams to show the variation in output conspicuously placed around the plant and systematically brought to the attention of the employees have proved helpful in some shops. There has been a great deal said about the present low efficiency of labor, but in one case at least where comparative records were established they resulted in an increase in production which brought the output well above the previous mark.

Railway Shop Grinding Needs

There is no doubt of the important economies effected in automotive and other industries from the introduction of modern grinding machinery and methods. Why should not railway shops benefit in a similar way. Grinding makes possible higher production and decreases the unit cost. More accurate work can be done and the extensive use of ground crank shafts and bearings proves that there is no inherent objection to grinding on this score. The old argument that particles of grit adhere to and become imbedded in a ground steel surface has been refuted not only by experience in the automotive industry, but by the experience of several railway shops that have practiced the grinding of axles and crank pins for a long time with satisfactory results.

At no time in the history of American railroads has there been a more crying need for increased output in both railway repair shops and roundhouses than right now. Why then do we find such a lack of modern grinding machines in railway shops, when, according to machine tool experts throughout the country they are absolutely necessary to the most economical shop operation?

Two answers may be given to this question. There are still a few machine shop men who do not believe in grinding methods applied in railway shops because their fathers did not use those methods. Needless to say men of this type, whose minds always dwell in the past, are in the small minority. Most machine foremen are not only willing but anxious to install any machine or method that will help increase production. A second large group of men object to grinding because their entire acquaintance with grinding ma-

chinery has been acquired in operating the antiquated machines in their individual shops and in vainly trying to get production results.

For example, the main repair shop of a certain eastern railroad is provided with two grinding machines, both eight or ten years old and entirely too light for the work to be done. The guide grinder, in addition to being too light, is of the horizontal spindle type and takes from two to four hours to grind an 84-in. guide that could be ground on a modern machine in approximately one hour. The machine foreman in charge uses this machine to its capacity, but merely as a means of reducing the planer work, and it is no wonder he does not have a high opinion of guide grinders.

The other production grinding machine in this shop is a piston rod grinder used occasionally to grind valve stems. In addition to being too old and light for accurate work the machine is not large enough to swing the heaviest class of piston rods, which accordingly have to be turned and rolled on an engine lathe. The face of the grinding wheel used with this machine is only 1½ in. wide and to call the grinder a production machine is a serious misnomer.

Conditions similar to those outlined above are only too common in railway shops and the fault should not be laid primarily at the door of the machine foreman in charge. He is not necessarily an old fogey with Chineselike respect for his ancestors and their ways. More likely than not he has placed his requisition for the tools necessary to bring his shop up to a modern production basis and, while waiting for the new tools, is using his old equipment to the best advantage possible.

For various reasons during the past two years it has been difficult and almost impossible to get the new machinery needed for efficient shop operation but the situation has now changed. More capital is available for additions and betterments and the absolute necessity for improved facilities is apparent to all. Within the past three weeks orders for $100,000 of new machine tools have been placed by each of two different railroads in the East and definite inquiries have been made by several other roads.

It is earnestly urged that those responsible for railway shop output look into the possibility of increased production and decreased costs by the more general use of grinding machinery. For such operations as truing piston rods, valve stems, guides and links, machining journal bearings, crank pins and other important parts, less material is removed by the grinding operation than by any other. This insures a quicker job at less cost and a longer life for the part ground. The resultant saving in material, labor and time can be computed in dollars and cents and will more than pay carrying charges on an investment in new grinding machinery.

What Do You Think?

Many valuable suggestions in the interest of increased economy and efficiency will be found throughout this issue. You may not approve of some of the methods described or you may have concrete data or information that will prove their value. Perhaps you can improve upon them or offer better suggestions. If so, tell the Editor.

To secure the co-operation of the shop mechanics Mr. McManamy in the article on page 233 advocates forming a shop committee. What do you think of the plan? Will it work?

Is there really anything to all this talk about modern apprenticeship methods in a railroad repair shop? Mr. McManamy seems to think so. (See page 235.) What has been your observation and experience?

A new type of grain car is described on page 209. Would it help in handling the grain traffic on your road?

Are you following the series of articles on the inspection of freight equipment by Mr. Sillcox? Can you add something of value to this series? If you can, the editor wants to know about it.

Can you apply the method of graphic production control described on page 227 in your own shop?

Will the information regarding heat treating methods in the article on page 236 help improve your blacksmith shop practice?

All these articles are intended to be of direct assistance to the readers. What do you think about them? The editor wants to know and will really appreciate brickbats more than bouquets if they will help him to make the *Railway Mechanical Engineer* more effective.

COMMUNICATIONS

CAR DEPARTMENT APPRENTICES

Chicago.

To the Editor:

I was glad to read your editorial in the December issue of the *Railway Mechanical Engineer* and hope that it will be the means of awakening others to the present situation in the car department of railroads all over the country. If not through the training of apprentices, from what source are the men to be recruited who must man the car shops in the future? House carpenters and others eligible for employment as full-rated car men have seldom had any experience in car work. How are they to get such experience?

If car men are to be recruited from the ranks of apprentices, is the present schedule of work, the length of the course or the rate of pay sufficiently attractive to induce enough young men to take up this work? Will not all three of these features need to be changed?

You state that perhaps it was the intention that a young man desiring or perhaps needing a higher rate of pay than that provided for regular apprentices might first work two years as a helper and then serve three years as a helper apprentice, the increased earnings offsetting the greater time required to learn the trade. But is there any assurance that if he starts in as a helper that in two years he will be advanced to a helper appenticeship? Are not helper apprentices to be selected in the order of seniority? Will not the majority of helpers now in the car shops be too old for apprenticeships before they are eligible? Moreover, the majority of boys at the age at which they enter upon other apprenticeships are not sufficiently developed physically to be strong enough for the heavy work of the freight car shops.

Should there not be a different course for apprentices preparing for work in the coach or cabinet shop from that given those being trained for freight car work? Would those capable of doing the former be content with the latter?

Would not a shorter course, say two and one-half or possibly three years, be sufficient for training freight car men, and with such a course should not the age limits be changed and the rates of pay increased so as to make such a course more attractive to those of maturer years, physically strong enough to meet the full requirements of the freight car shop?

I believe the present situation a serious one and the questions raised worthy of careful consideration.

A Car Man.

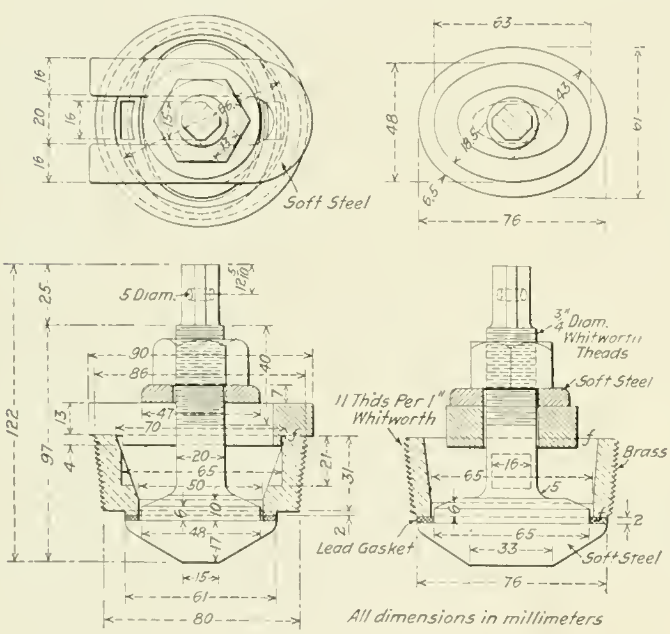
HANDHOLES Vs. WASHOUT PLUGS

New York.

To the Editor:

The editorial which appeared in your January issue under the title "Accidents due to Washout Plugs," raises a question of great importance. There is no doubt that a plug in a boiler for washout purposes is a very unsatisfactory arrangement and a very dangerous one, especially when one considers the large diameters of the arch tube plugs in a modern boiler. Every time a washout plug is taken out and put back in, the fine thread wears a little; very often a rod is used for shaking the scale off the sheets; when put through the threaded opening in the boiler sheet and turned around a few times, the rod damages the fine thread and the crossing of threads by screwing the plug in is quite probable. For these reasons the locomotive practice of many European countries forbids the application of screwed washout plugs in locomotive boilers and prescribes the use of handholes only.

In a country where plugs were practically unknown for the last 25 or 30 years, a few hundred locomotives arrived during the war from abroad with screwed washout plugs. Within less than a year two accidents have taken place; I am familiar with one of these. The fireman was scalded to death as a result of an attempt to tighten a leaky arch tube washout plug in violation of the rule existing on the road, that no washout plug should be tightened under steam—but evidently the temptation to stop leakage overpowered the poor fireman.



Handholes Used on Russian Locomotives

Attached you will find a drawing of a Russian standard washout handhole, which is applied in the corners of back sheets and throat sheets and in the front tube sheets on all Russian locomotives. A brass bushing with an elliptical hole is screwed in the sheets permanently and a corresponding elliptical inside cover is put through the bushing and secured in position by means of an outside clamp, washer and nut. The cover is kept tight from inside by the steam pressure and a copper or lead gasket. This makes a very substantial construction, which is absolutely safe. Leakage occurs very seldom, and the tightening of the nut with a regular wrench in case of leakage is quite permissible.

For the arch tube openings in the back head and throat sheet, handholes of the same type are applied, but of a larger size, the average outside diameter of the threaded bushing being 4 5/16 in., and the elliptical opening 3 in. by 2 13/16 in. Two hundred Decapods built for Russia, which were turned over temporarily to the United States Railroad Administration, have handholes of the type described, and I have never heard any complaint from any of the roads where they are running with reference to the handholes. The handholes are sometimes criticized as taking up more time for putting in place than the plugs; but the difference, which amounts only to a few minutes per handhole, is very small as compared with the time necessary for the complete washout of a boiler. Besides that, this criticism must be put aside in view of the great advantage of the handholes—avoiding accidents and sparing human lives. During the fiscal year ending June 30, 1919, 30 accidents occurred due to washout plugs, resulting in one man being killed and 34 injured. Is it not worth the trouble to adopt the handholes for washout openings in the locomotive boiler?

A. Lipetz,
Russian Mission of Ways of Communication.

I. A. DEFENDS THE CHIEF CLERKS

While Jap detector are investigating RR shop efficiency he learn of magnificent treatment handed to Chief Clerks.

Learn Chief Clerk are regarded Supernumary by Soviet Unions and as such it becomes bounden duty to fight own battle. Difficult to accomplish as aforesaid Unions maintain strangle hold on Golden Eagles and hand to Cobbler, who are made Mechanic by decree of Soviet aided by Imperial Government Wage Board.

Chief Clerk, before the German brain storm impel Imperial Government to defend Sacred Rights, received $90 to $100 per month, while clerks $45 to $70 per month. By unknown patented process of Imperial Wage Fixers, fact is established

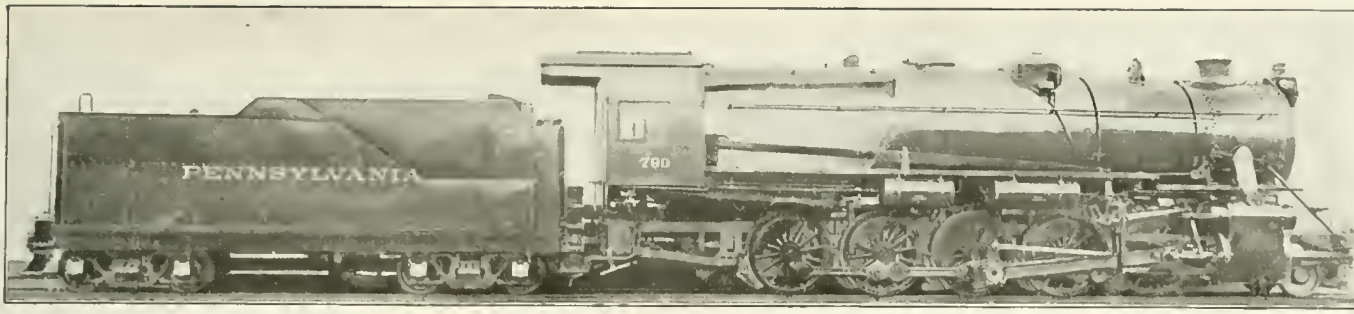
Chief Clerks Register Despair

that least a clerk must have to outfit with filmy draperies effected by haughty girls are $87.50. Supplement No. 7 to G. O. 27 which set forth this decree, also provide for married chief clerk with wife and children bountiful sum of $115 to $125 per month.

Efforts secure substantial justice are no avail. Chief Clerks register Despair. However, continue to keep Hon. MM posted what are of interest in your esteemed journal, latest instructions S.M.P. on applying spring seats for Engineers Soviet, labor turnover shop, newest ruling of wage adjustments, etc., wondering "How long, O Lord, how long will one suit last," as he are impotent to provide otherwise. Chief Clerks hopeful return RR March 1 make possible securing much needed new suit, if not must stay home.

In next letter will record plight of despised storekeeper.

Ino Amsura.



Pennsylvania Decapod, Type I1s

PENNSYLVANIA DECAPOD SHOWS HIGH ECONOMY

Report of Tests Comparing I1s, Hand and Stoker Fired, with the Performance of the L1s Mikado

IN 1916 the Pennsylvania Railroad built a locomotive of the 2-10-0 type with cylinders working at a maximum cut-off of 50 per cent. This locomotive with minor alterations was adopted for heavy freight service and a large number of the clas I1s, as this type is designated, are now in use. The design of this locomotive was described in the *Railway Mechanical Engineer* for July, 1917, page 370. Details of the performance as disclosed by the results of test plant trials, are now available in Bulletin No. 31 (copyright 1919 by the Pennsylvania Railroad), from which the information in this article has been secured.

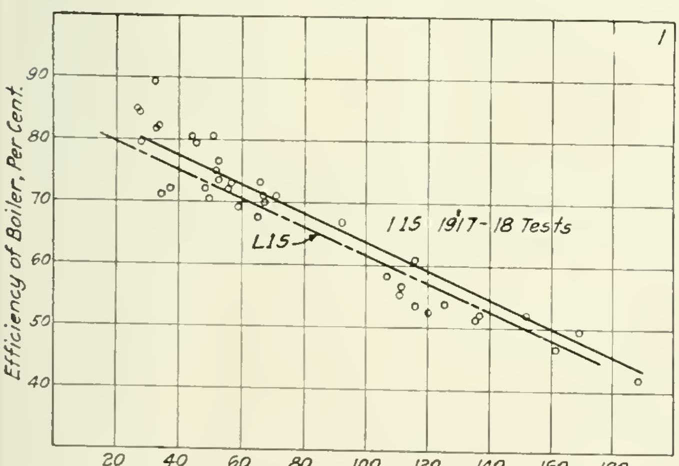


Fig. 1. Rate of Combustion and Boiler Efficiency

In discussing the considerations which led to the development of the I1s the bulletin points out that many locomotives, in helping service especially, are worked almost continuously with a cut-off near the end of the stroke. If they were designed so as to work at but 50 per cent cut-off when in full gear, without a sacrifice of drawbar pull, there would be gained the difference between the coal and water rates at full stroke cut-off and those at half stroke, or a saving of approximately 25 per cent. The locomotive needed at a number of points on the Pennsylvania was one having a drawbar pull 25 per cent greater than that of the class L1s, Mikado type, or one having a pull of about 75,000 lb. at 10 miles an hour. A study of such a locomotive, with a limited or restricted cut-off in a two-cylinder arrangement, indicated that the desired result could be obtained with a half stroke maximum cut-off, giving a turning moment diagram very similar to that of locomotives cutting off at full stroke.

For the purpose of developing a practical means of obtaining the economies above outlined, a locomotive was built and placed on the locomotive testing plant before going into road service, as the innovations in design made it especially desirable to have complete test results before building additional ones. As a result of the tests and the general performance of the locomotive in service, certain alterations were found advisable.

Description of the Locomotive

Locomotive No. 790, as finally arranged for these tests, is of the Decapod or 2-10-0 type with two cylinders 30½ in. in diameter and having a stroke of 32 in. The boiler pressure is 250 lb. per sq. in. and the maximum cut-off is limited to approximately 50 per cent of the stroke. In many particulars the design follows closely that of the class L1s, Mikado type, which preceded it.

The table following shows how the locomotive compares with the class L1s in certain leading dimensions. The total heating surface is about 12 per cent larger than that of the class L1s, and the total weight about 16 per cent greater. The grate areas of the two locomotives are alike.

GENERAL DIMENSIONS OF LOCOMOTIVES OF THE I1s AND L1s CLASSES

	Class I1s 790	Class L1s 1,752	Increase of I1s over L1s, per cent
Weight in working order, total pounds..	371,800	320,700	15.9
Weight on drivers, working order, pounds	342,050	240,200	42.4
Driving wheels, diameter, inches.......	62	62	...
Cylinders (simple), inches...........	30½ by 32	27 by 30	37.6 Vol.
Heating surface, tubes (water side), sq. ft.	4,043.94	3,715.71	8.8
Heating surface, firebox (including arch tubes), sq. ft.	290.20	301.51	3.8 Dec.
Heating surface, superheater (fireside), sq. ft.	1,478.91	1,171.63*	26.2
Heating surface, total (based on water-side of tubes), includ. superh., sq. ft.	5,810.25	5,188.85	12.0
Heating surface, total (based on fireside of tubes), including superheater, sq. ft.	5,423.12	4,847.72	11.9
Grate area, sq. ft.	70.0	70.0	0.0
Boiler pressure, pounds per square inch.	250.0	205.0	22.0
Valves	12-in. piston	12-in. piston	...
Valve motion, type	Walschaert	Walschaert	...
Firebox, type	wide, Belpaire	wide, Belpaire	...
Tubes, number	244	237	...
Tubes (outside diameter), inches......	2.25	2.25	...
Flues (for superheater), number.......	48	40	...
Flues (outside diameter), inches.......	5.5	5.5	...
Tubes and flues, length, inches........	228.32	228.51	...

*This is the heating surface of the 17-ft. superheater. The standard length superheater for the L1s is now the same as for the I1s or 18 ft., with a heating surface of 1,234.65 sq. ft., but the 17-ft. superheater was used in the L1s tests herein reported. The I1s superheater surface is about 20 per cent larger than that of the 18-ft. superheater for the L1s.

Tractive Force

In calculating the maximum tractive force of this locomotive the mean effective pressure reaching the drawbar

cannot be taken as the usual 85 per cent of the boiler pressure, because of the limitation of the cut-off. Indicator diagrams, made in road service, at starting in full gear, show an average m.e.p. of about 75 per cent of the rated 250 lb. boiler pressure, or somewhat more, according to the time in which the first revolution is made, controlling the amount of steam passing through the auxiliary port. With 30½-in. by 32-in. cylinders, the calculated maximum tractive force may, therefore, be assumed to be that based on 75 per cent of the boiler pressure, or 90,000 lb. The ratio of weight on drivers to this calculated tractive force is 3.8. After the first few revolutions, it is expected that the drawbar pull will fall to that due to about 70 per cent of boiler pressure as m.e.p., or 84,000 lb., with a ratio of 4.07.

Boiler

The boiler is similar in design to the boiler of the class Lls, but the boiler tube surface and superheating surface are both somewhat larger. The superheater has 48 elements, where the class Lls has 40. The length of tubes and superheater flues, 19 ft., is the same as in the class Lls locomotive.

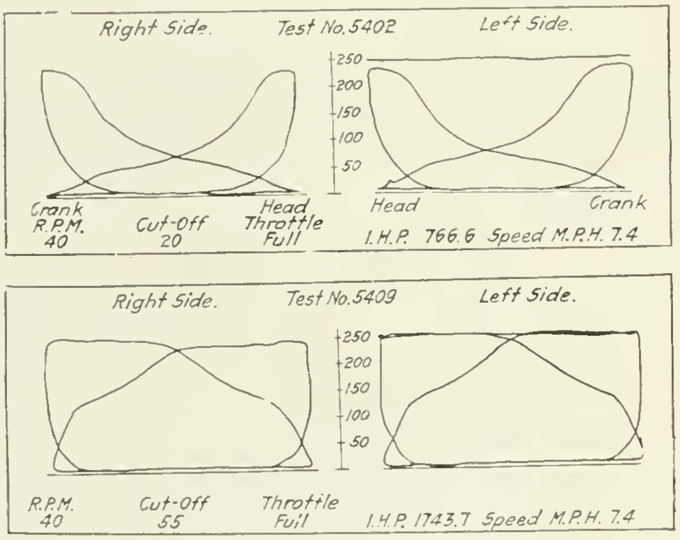


Fig. 2. Typical Indicator Diagrams

The details of the cylinders, ports and valves were described in the article referred to above. It may be well to mention that the valves have a travel of six inches in full gear and to obtain a short cut-off with this long travel, it was necessary to make the steam lap two inches. Full gear cut-off with six-inch valve travel is at 50 per cent of the stroke; however, to distinguish tests in full gear cut-off at slow speed, with allowance for steam passing through the auxiliary ports, such tests are marked 55 per cent cut-off as determined from the indicator diagrams. The lead of the valves in full gear is 3/16 in. The exhaust lap is ⅛ in.

Auxiliary ports are cut in the valve cages, 1¾ in. in advance of each of the main steam ports, and are intended to assist in starting; however, they are in action at all times when the locomotive is moving under steam. The ports are ⅛ in. by 1½ in., with a steam lap of ¼ in., and are located at each end of each cylinder at the bottom of the valve cage or bushing, making four ports in all.

Coal

Over 70 tests were made to develop the performance of the locomotive, and of these tests 39 were fired by hand with run-of-mine coal. In the 1917 tests Jamison coal was used, but on account of the difficulty in getting this coal in 1918, the tests were made with Crows Nest coal. These two coals are from the same region and vein and are alike in many respects. This is further illustrated by the average analyses, given in the following table, which have been made from all of the coal used in the hand-fired tests:

	Jamison coal 1917	Crows Nest coal 1918
Fixed carbon, percentage	56.21	56.80
Volatile combustible, percentage	31.34	29.68
Ash, percentage	11.67	12.26
Moisture, percentage	0.97	1.25
Total	100.19	99.99
Sulphur, percentage	2.15	1.41
B. t. u. per lb. dry	13,429	13,420
B. t. u. per lb. combustible	15,221	15,324

Tests with Hand Firing

Boiler Performance

Pressures and Temperatures.—An average boiler pressure within about four pounds of the rated pressure of 250 lb.

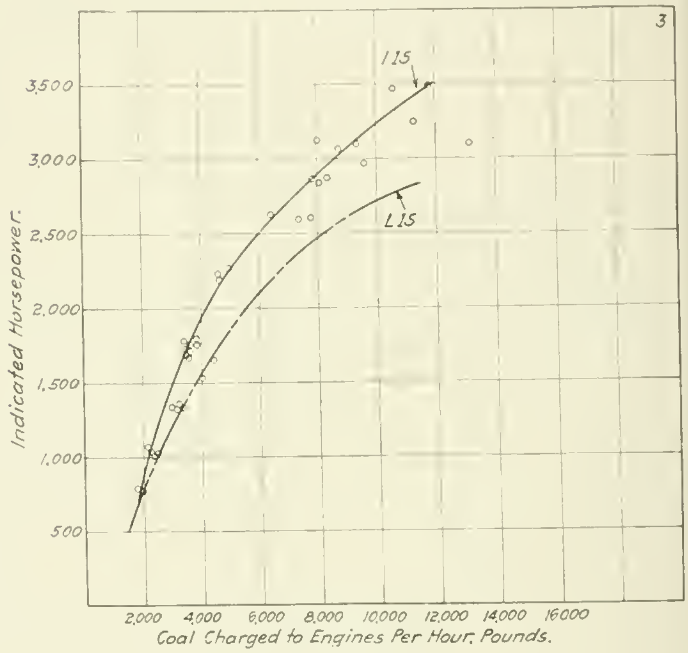


Fig. 3. Coal to Engines and Indicated Horsepower

per square inch, was maintained in all of these tests. The maximum pressure drop, or loss between the boiler and branch pipe was 18 lb., this drop being at a rate of steam flow of 58,000 lb. per hour. The exhaust steam pressure

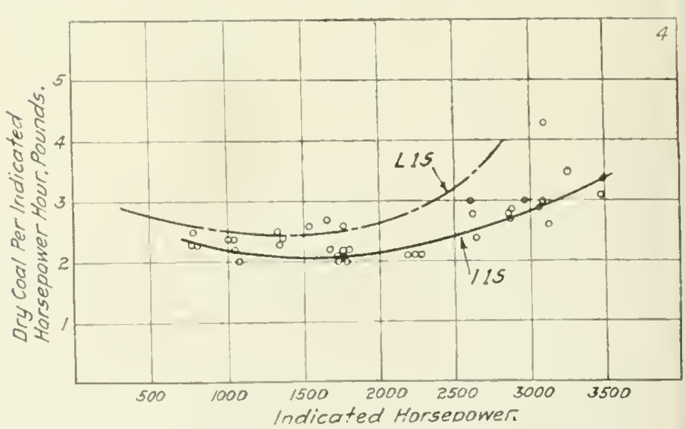


Fig. 4. Indicated Horse Power and Coal (Average for All Cut-offs)

shows a maximum of 16.3 lb. per square inch. Even with a boiler pressure of 250 lb., the maximum superheat temperature was 282.8 deg., which is nearly as high as has been obtained on any locomotive on the test plant, all of which have had a boiler pressure at or below 205 lb.

Combustion, Draft and Temperature.—In general, the

draft or vacuum was higher in the Ils than in the Lls at all rates of evaporation. This is to be expected, as the exhaust nozzle area was 35.8 sq. in. for the Ils and 38.3 sq. in. for the Lls. Though not greatly different, the smokebox temperatures are somewhat higher than in tests of the Lls.

The feedwater temperature was between 37.3 and 64.9 deg. The firing was all by hand as the locomotive was not at this time equipped with a stoker. The rate of firing reached 189 lb. an hour per square foot of grate, and at this rate the evaporation per square foot of heating surface was

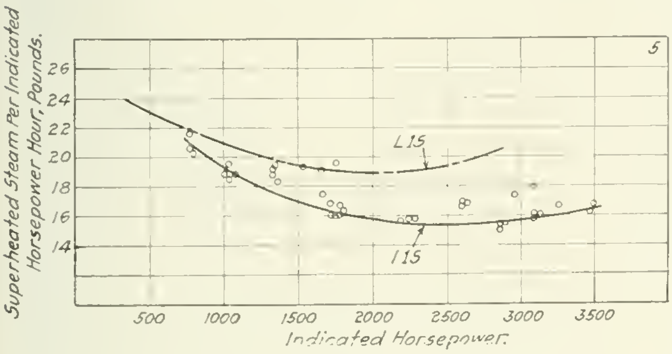


Fig. 5. Indicated Horse Power and Steam (Average for all Cut-offs)

10.3. The maximum rate of firing, in pounds per hour, was 13,226.

Evaporation.—The evaporation of this boiler appears to be less than was obtained from the smaller Lls boiler, but when the higher pressure and superheat of the Ils are considered, the maximum equivalent evaporation of the Ils is considerably above that of the Lls. The equivalent evaporation per pound of coal is illustrated by Fig. 15. The evaporation per pound of coal and the boiler efficiency results are about the same as were obtained in 1917 (see Fig. 1.). The equivalent evaporation per square foot of heating surface for the Ils reached a maximum of 14.7 lb. per hour.

Superheat.—The Ils shows a maximum superheat of about

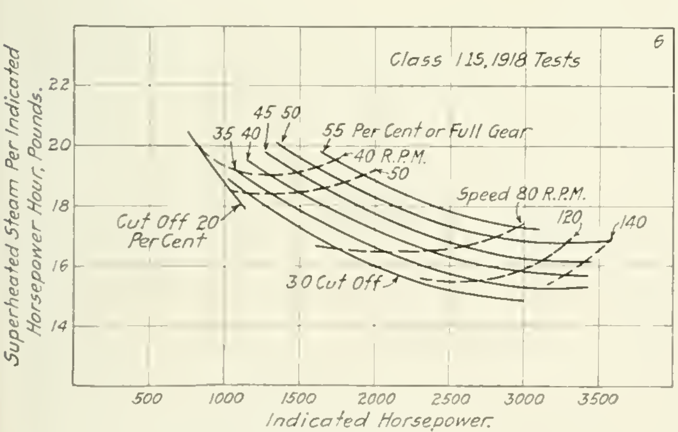


Fig. 6. Water Rates at All Cut-offs, Class Ils

280 deg. and at a rate of firing of 11,000 lb. per hour the superheat is about 15 per cent higher than for the Lls when equipped with a superheater of the same length as in the Ils, or 18 ft. When these two superheater surfaces are compared, that of the Ils is larger by about 20 per cent, on account of the larger number of elements.

The normal saturated steam temperature for the Ils is 406 deg. and for the Lls, with a boiler pressure of 205 lb., it is 389.5 deg. It would appear to be more difficult then to superheat the steam from the Ils boiler on account of its higher initial temperature, but notwithstanding this, a higher maximum superheat was obtained, although it is somewhat lower over part of the range.

The water heating surface of the Ils boiler is 8.8 per cent, the total heating surface 12.0 per cent, and the fire area through the tubes 7 per cent greater than the corresponding parts of the class Lls. For these reasons it was expected that an evaporation somewhat higher than in the case of the Lls class, over 59,000 actual, or 77,000 equivalent pounds per hour, would be possible when using an exhaust nozzle seven inches in diameter, or the same diameter as was used on the Lls.

With a seven-inch diameter exhaust nozzle (1917 tests), an evaporation of about 53,600 actual, or 72,500 equivalent pounds per hour was obtained. This was not considered sufficient, in view of the performance of the class Lls, and many changes were made in the arrangement of the diaphragm in the smokebox and different forms of stack were tried. Finally, by reducing the nozzle diameter to 6¼ in., an evaporation of 59,300 actual, or 81,900 equivalent pounds was obtained.

The tests of the 1918 series, beginning with 5401 and ending with 5416, were made with a seven-inch exhaust nozzle, and it was used again in tests 5431 to 5438. Test 5412 at 80-55-F, evaporating 51,280 lb. per hour, proved to be the limit with this nozzle and smokebox arrangement. It was found, after test 5416, that cinders were accumulating in the front end, and to overcome this the exhaust nozzle was reduced to 6¾ in. and a deflector plate, eight inches wide, put on the edge of the table plate in front of the nozzle. This deflector made the gas passage, at the smallest area, the

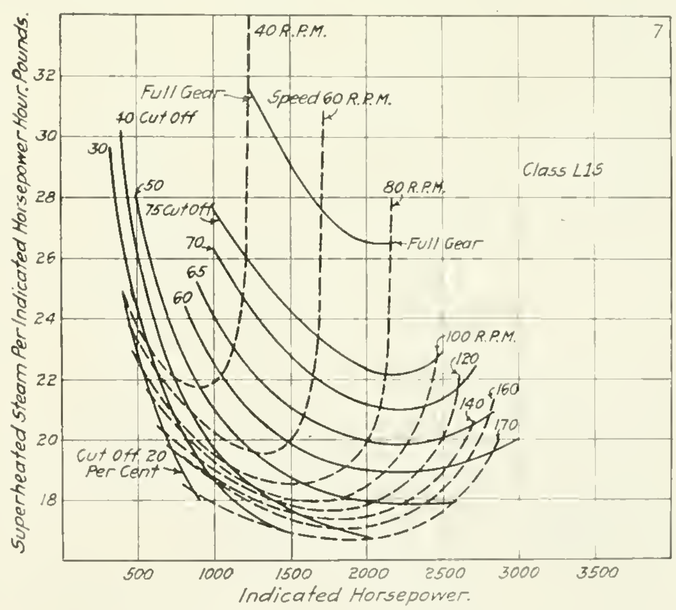


Fig. 7. Water Rates at All Cut-offs, Class L1s

same proportion of the fire area of tubes as on the classes Lls and K4s, where it is 68 per cent.

Arranged in this way, the evaporation, in test 5443 was 58,300 lb., or an increase of about 14 per cent over the evaporation that could be obtained with the seven-inch nozzle without the deflector. When equipped with a stoker in later tests, an evaporation of 60,906 lb. was obtained, showing that the expected evaporation is easily possible with this locomotive.

While in the earlier tests a 6¼-in. exhaust nozzle was used, in the final tests it was found possible to use a 6¾-in. nozzle, but not a 7-in. The boiler conditions had been improved by the changes in the stack and front end, so that the 6¾-in. nozzle gave draft conditions as good and a

capacity as high as could be obtained with the 6¼-in. nozzle and the earlier arrangement of the front end.

Engine Performance

The engines of this locomotive, compared with long cut-off locomotives as to economy in coal and steam, have yielded expected results. The tests have shown that the restricting of the cut-off has had the desired effect in that, in full gear, where the bulk of the work is done, this locomotive operates much more economically than the Ls. This advantage, as expected, is reduced as the engines are cut back, but it is not until we have gone below the most economical cut-off for both locomotives that the Ls and Ils show the same economy at a given horsepower. This, moreover, is the case only at the lower horsepower (in short cut-offs at low speeds), that is, for but a small portion of the work done by the locomotive when in normal railroad service.

Indicator Diagrams and Action of Starting Ports.—Representative indicator diagrams are shown in Fig. 2. The principal point of interest in these diagrams is the action of the auxiliary starting port. It opens before the opening of the main port, having a lead of 1 15/16 in. in the tests

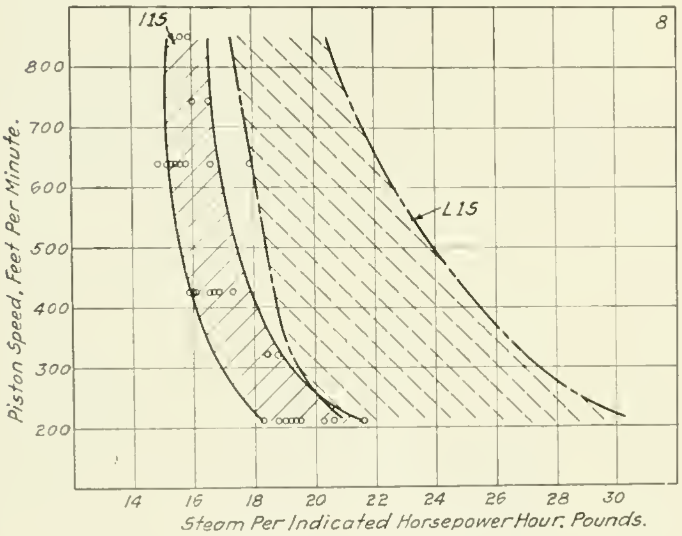


Fig. 8. Piston Speed and Water Rate

here recorded, as against 3/16 in. for the main port and, on the indicator diagrams, the effect caused thereby can scarcely be noticed. Considering the cards for full gear, there is no evidence that the auxiliary ports admit a sufficient amount of steam to hold up the admission line appreciably, after the cut-off of the main port. The testing plant conditions in starting are not the same as on the road, on account of there being little or no resistance to turning the locomotive wheels and no rolling load, in the form of the locomotive itself and the train.

Indicated Horsepower.—The test results in indicated horsepower are plotted on Fig. 3. The range of horsepower was between 766.6 and 3,486.1. The highest power was obtained at a speed of 140 r.p.m, which is equivalent to 25.3 m.p.h.

The superheated steam used per i.h.p. hour was between 14.9 and 21.6 lb. In 12 of the tests the steam used per i.h.p. hour was 16 lb. or less. On 16.6 lb. of steam per i.h.p. hour, an indicated horsepower of about 3,500 was developed.

Many tests show a coal consumption of between two and two and a half pounds per horsepower hour, while the maximum rate, neglecting test No. 5417 as abnormal, was less than three and a half pounds per i.h.p. hour. The curves as drawn for the class Ils, Figs. 4 and 5, show lower results in steam and coal per unit of power than for the class Ls at any power.

The indicated horsepower at 7.4 miles per hour, in full gear, is 1,743.7. With the Ls at the same speed in full gear it is about 1,220. This is an increase in power over the Ls of about 43 per cent. The maximum horsepower was obtained at 25 miles per hour and 45 per cent cut-off; this was 3,486. With the Ls the maximum power at this speed was 2,755, or about 80 per cent of that of the Ils. The Ls has developed on the test plant 2,954 hp. at a speed of 29 m.p.h.

Steam Rate Curves.—In Figs. 6 and 7 curves are plotted

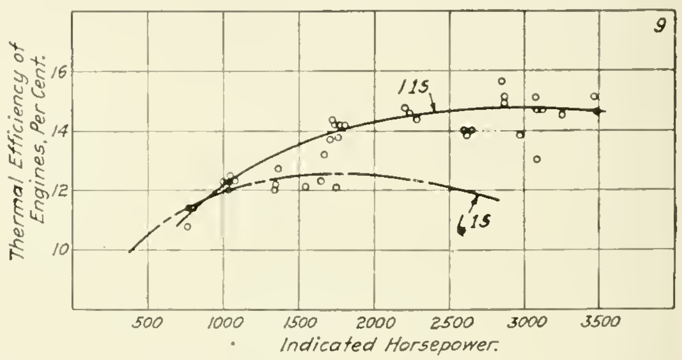


Fig. 9. Indicated Horsepower and Efficiency of Engines

showing the whole range of weight of steam per indicated horsepower hour for the locomotives, classes Ils and Ls. Considering the speed of 40 revolutions per minute or 7 m.p.h., and full gear, it is found from these diagrams that the Ils developed 1,740 i.h.p. and used about 19.5 lb. of steam per horsepower hour, while the Ls developed 1,230 hp. and used 31.5 lb. of steam per horsepower hour. At a speed of 120 r.p.m., 22.1 m.p.h., and at a cut-off of 50 per cent, for the Ils the horsepower is about 3,280, while for

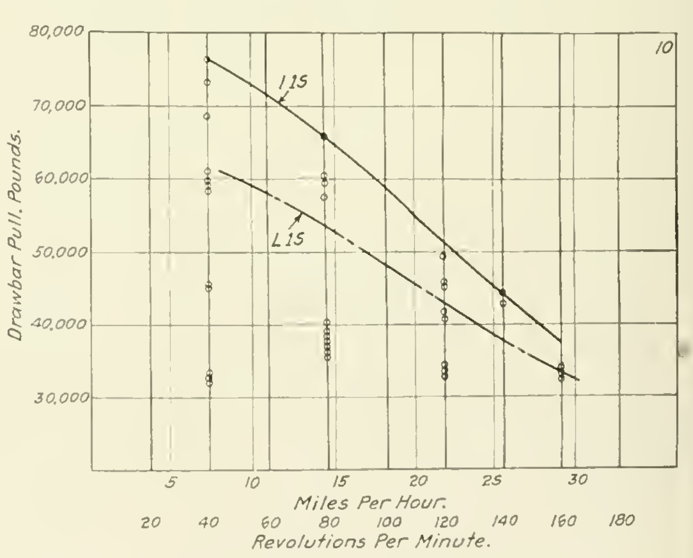


Fig. 10. Drawbar Pull of the I1s and L1s at Various Speeds

the Ls it is about 2,050, and the steam per indicated horsepower for the Ils is 16.8, while for the Ls it is 18.0. In this latter case little or no saving would be expected and the difference may be attributed to difference in quality (pressure and superheat) of the steam. In full gear, at low speed, the reduction in the steam per indicated horsepower by the Ils over the Ls is, as above indicated, approximately 38 per cent.

Piston Speed and Water Rates.—The water rate of the locomotive improves to a certain extent with an increase in

piston speed, and this is shown by the plotted results in Fig. 8. The weight of steam per indicated horsepower for the Ils locomotive is in a separate zone from that of the Lls, and less steam is used when the two locomotives are tested under like conditions.

On account of the small exhaust nozzle and higher boiler pressure, the back pressure was in general somewhat greater than for the Lls.

Thermal Efficiency of Engines.—The thermal efficiency of the engines alone, referred to indicated horsepower, calculated according to the method of the A.S.M.E., is shown in Fig. 9. This efficiency is the proportion of the total heat consumed which is converted into work in the cylinders. The heat considered is that in the steam in the branch pipe, above an ideal feedwater temperature which is assumed to be that as observed of the steam in the exhaust pipe. These efficiency results show that there is much improvement in the Ils over the class Lls. The efficiencies of the locomotive are between 10 and 16 per cent, while those of the class Lls are between 10 and 14 per cent.

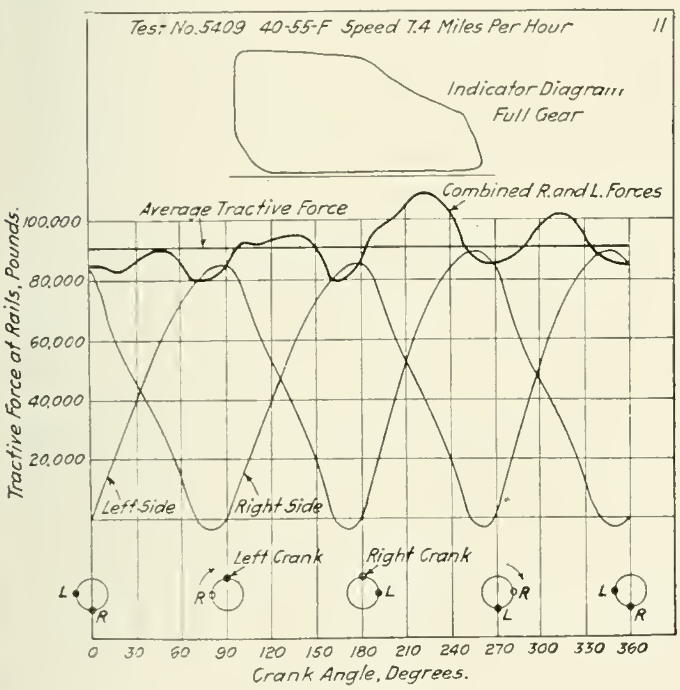


Fig. 11. Tractive Effort Curves, Full Gear, Class I1s

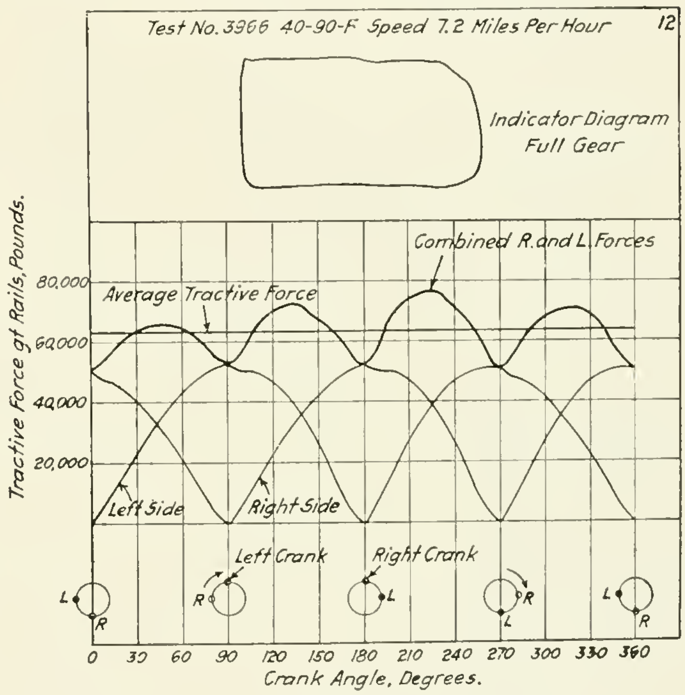


Fig. 12. Tractive Effort Curves, Full Gear, Class L1s

Locomotive Performance

The dynamometer horsepower shows increases and economies closely following those for indicated horsepower. Many tests have a coal rate of 2½ lb. (see Fig. 16) and a steam rate of less than 18 lb. The minimum rate was 16.8 lb. of steam per d.h.p. hour. Both the coal and water rates are below those of the class Lls for all dynamometer horsepowers.

The drawbar pulls obtained upon the testing plant are shown in Fig. 10. To be 25 per cent greater than the pull of the Lls at 40 r.p.m., the Ils should have a pull of about 75,000 lb., and this pull was considerably exceeded. In the tests with 30-in. cylinders at a speed of 40 r.p.m. or 7½ m.p.h., the drawbar pull on the test plant was 68,000 lb., and later on the road about 76,000 lb. With the new 30½-in. cylinders, on the test plant the pull at this speed was 76,000 lb.

Cylinder Tractive Force.—Comparative turning moment or cylinder tractive force curves for the class Ils Decapod type, and the class Lls Mikado type, are shown in Figs. 11 and 12. It will be seen from these diagrams that the turning moment in the case of the class Ils, cutting off at half stroke, forms nearly as smooth a curve as for the class Lls, cutting off at nearly full stroke, and therefore that the advantages of a favorable cut-off are obtained in this locomotive without introducing high peaks in the curve or any unusual tendency toward slipping of the driving wheels.

Machine Friction.—The machine efficiency of this locomotive is plotted in Fig. 13. The highest efficiency is 91.7 per cent. At the lowest speed of the tests, 7.4 m.p.h. in full gear, it was 85.6 per cent. In tests of the class Lls the machine efficiency was in some cases as high as 95 per cent and at 7 m.p.h., in full gear, it was 94 per cent. The thermal efficiency of the locomotive (proportion of total heat consumed converted into work at the drawbar) is shown in Fig. 14. The Ils developed a maximum efficiency of 8.1 per cent, while the highest atained by the Lls was 7.0 per cent.

Tests with Duplex Stoker

Following the hand-fired tests locomotive No. 790 was equipped with a Duplex stoker. It was then returned to the test plant and the tests continued with the stoker in use. The stoker was piped so that its exhaust steam could be turned into the base of the elevator screws to dampen the coal, the claim being made that this will reduce the smoke.

For the remaining tests the stoker was used without any hand firing and the test conditions duplicated as nearly as possible the hand-fired tests. Some of the stoker-fired tests were made to obtain the steam consumption of the locomotive only and were run for too short a time for reliable coal data. These have not been plotted on the diagrams.

The stoker speed at first was found to be too low, not over 40 strokes per minute, and in order to increase the speed changes were made in the steam ports of the stoker cylinder by enlarging and extending them. The exhaust pipe from the stoker engine was also enlarged to two inches. After these changes the stoker could be run at 48 strokes per minute, and it was possible to fire all of the coal that could be burned. The same kind of coal was used for the stoker tests as for the hand-fired tests, namely, Crows Nest run-of-mine.

The exhaust steam from the stoker cylinder was led to a condenser and the condensed steam weighed in the first

nine tests. From these records it was found that about ¼ lb. of steam was used per double stroke or revolution of the stoker, and for the remaining tests the stoker exhausted to the atmosphere and the steam used was calculated. The steam used by the stoker steam jets could not be measured directly and was calculated by the Grashof formula.

Coal.—The average analyses of the Crows Nest coal used for the hand-fired and stoker tests, are shown in the following table and indicate a very small difference.

	Hand fired	Stoker fired
Fixed carbon, percentage	56.80	58.68
Volatile combustible, percentage	29.68	29.92
Ash, percentage	12.26	10.18
Moisture, percentage	1.25	1.23
Total	99.99	100.01
Sulphur, percentage	1.41	1.54
B.t.u. per lb. dry	13,420	14,130
B.t.u. per lb. combustible	15,324	15,662

Results of Tests.—The results of the stoker-fired tests are plotted in Figs. 15 and 16, and on these diagrams the hand-fired test results, made immediately before the application of the stoker, are shown for comparison.

Maximum Capacity with Stoker.—It is evident from the tests that the evaporation and rates of firing are but little more than can be obtained by hand firing, so that the capacity of the locomotive was not increased by the stoker, but of course the maximum evaporation is obtained with much less exertion on the part of the fireman, and also it is evident that the maximum evaporation can be sustained for a longer time with the stoker.

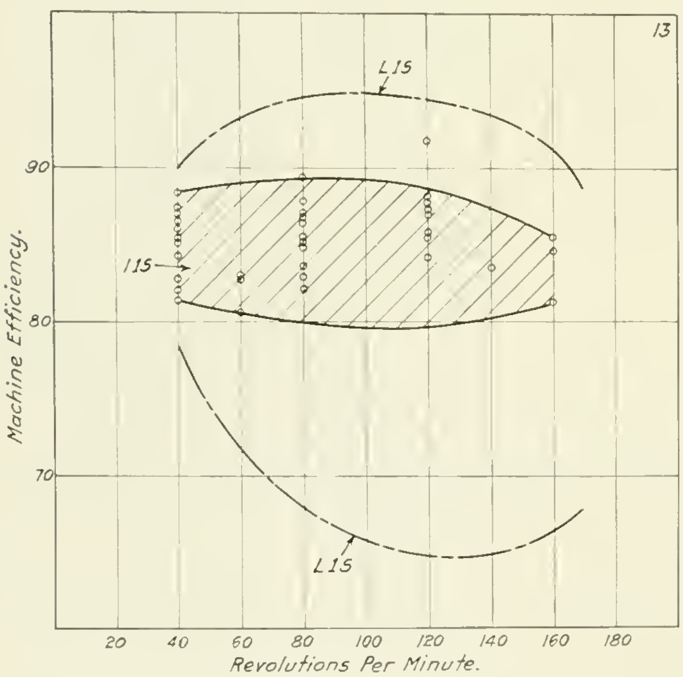


Fig. 13. Machine Efficiency

It was found that the boiler could not be forced much beyond an evaporation of 60,000 lb. per hour, indicating this to be the boiler limit for both hand and stoker firing.

Coal Economy with Stoker.—A further analysis of the stoker test results shows that hand firing is superior in evaporation per pound of coal at low rates of firing, but that this advantage decreases until, when the boiler is evaporating its maximum weight of water the stoker firing is no less economical than the expert hand firing. The advantage shown for hand firing is about 19 per cent when firing 40 lb. of coal per square foot of grate per hour, and decreases to nothing when firing 180 lb. per square foot. (See Fig. 15.) There is practically no difference in the superheat of the steam with or without the stoker. The range of the superheat is between 130 and 285 deg.

Stoker Exhaust to Conveyor.—The stoker engine ordinarily exhausts to the atmosphere, but there is also a pipe connection to the base of the elevator screws, and when this was used the coal was dampened by the exhaust steam. With this connection in use in test No. 5470 there was a marked reduction in the smoke and also a smaller coal consumption, but as there was only one test made under these conditions no very definite conclusions can be drawn, although the indications are that there is some advantage to be gained by its use. The results obtained with it, compared with both hand and stoker-fired tests without it, are shown in the following table:

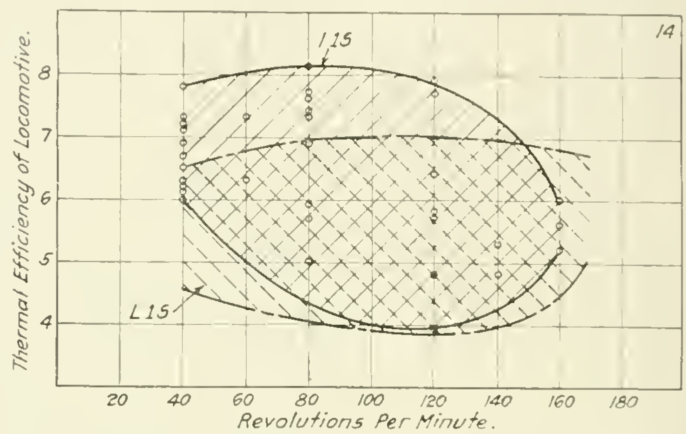


Fig. 14. Thermal Efficiency of the Locomotive

Test No.	Test designation	Coal fired, lb. per hour	Equivalent evaporation per lb. dry coal	Smoke percentage	Exhaust of stoker engine to—
Stoker-Fired Tests					
5,470	120-30-F	5,505	9.1	15.6	Conveyor
5,447	120-30-F	5,783	8.7	27.0	Atmosphere
5,449	120-30-F	6,019	8.3	22.8	Atmosphere
5,456	120-30-F	6,304	7.8	32.4	Atmosphere
Hand Fired Tests					
5,432	120-30-F	4,641	10.3	7.2	......
5,428	120-30-F	4,720	9.8	8.2	......
5,441	120-30-F	4,943	9.7	18.8	......

Steam Used by Stoker.—The estimated weight of steam used by the stoker ranged between 393 and 1,629 lb. per hour, and was about two per cent of the steam generated by the boiler. There was more hooking or leveling of the fire in hand firing than when the stoker was used. This would indicate that the stoker maintained a more nearly level fire than could be obtained by hand firing. The number of times the grates were shaken was practically the same for either hand or stoker firing.

Conclusions

With this boiler, carrying a steam pressure of 250 lb. per sq. in., no difficulty was found in superheating the steam to a high temperature. The water and superheating surfaces are larger than those of the class L1s locomotive and a greater equivalent evaporation was obtained.

The engines of this locomotive compared with long cut-off locomotives as to economy in coal and steam, have met expectations. The tests have shown that the restricting of the cut-off has had the desired effect in that, in full gear, where the bulk of the work is done, this locomotive operates much more economically than the L1s. This advantage, as expected, is reduced as the engines are cut back, but it is not until below the most economical cut-off for both locomotives that the two classes of locomotives show the same economy.

In the results of the tests which show power and steam used, the action of the stoker need not be considered, and it was found in many tests that the steam rate per i.h.p. hour was

16 lb. or less. At a rate of only 16.8 lb. of steam per hour an indicated horsepower of over 3,500 was developed. The saving in steam per indicated horsepower over the Ll s is very evident and, except at low horsepower at low speed, it is not possible to operate the Ll s at as good advantage as the Il s, and in full gear at low speed, the reduction in steam per indicated horsepower, over the Ll s is 38 per cent.

The maximum evaporation was obtained with the stoker with very little exertion on the part of the fireman. The stoker fired a fairly level fire, and could be operated under

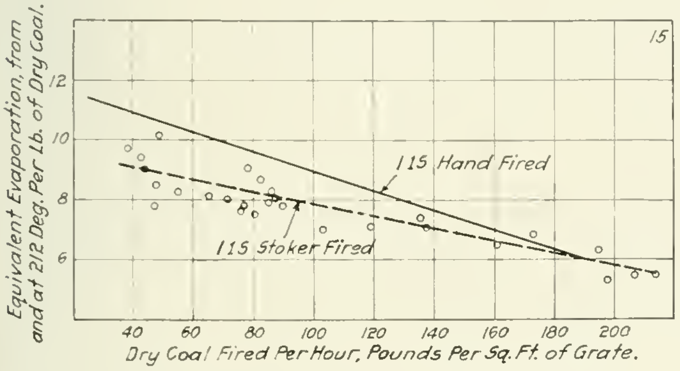


Fig. 15. Evaporation per Pound of Coal. Hand and Stoker Firing

all conditions in a satisfactory manner without any hand firing.

Except at the highest rates of firing, the stoker is wasteful in the use of coal, but appears to be no more wasteful than other stokers, and in addition has advantages over the other stokers tested, in ease of operation and in the absence of obstructions at the fire door and on the grates.

The estimated weight of steam used by the stoker was about two per cent of the steam generated by the boiler. The advantage shown for hand firing over the stoker firing in

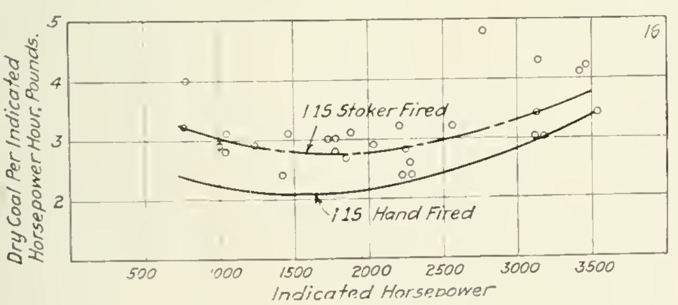


Fig. 16. Indicated Horsepower and Coal. Hand and Stoker Firing

equivalent evaporation per pound of coal is about 19 per cent when firing 40 lb. of coal per square foot of grate per hour, and decreases to nothing when firing 180 lb. per sq. ft.

With the stoker it is to be supposed that a greater number of firemen could obtain the full capacity of the locomotive than would be the case with hand firing, because of the ease of handling the stoker. Such considerations, combined with those of economy or capacity as shown by tests, in the case of locomotives of this class, must govern in deciding whether a stoker is necessary.

Labor's Share of Railroad Earnings.—Statistics of earnings and expenses of the railways in 1919 show that of the average earnings of a month of 30 days, labor received in wages the earnings of 17½ days of each month, fuel required the earnings of three days, material and supplies five days, taxes, etc., one and one half days, leaving the earnings of three days for net operating income.

ANATOLE MALLET

Anatole Mallet, the inventor of the compound locomotive which bears his name, died in Nice, France, in October, 1919. Mr. Mallet was born in 1837 at Carouge and was graduated in 1858 from the Central School of Arts and Manufactures in Paris. He was engaged in civil engineering work for several years, first with the Bureau of Direction of the General Company of Railroad Materials in France and later on the Suez Canal. In 1864 he was engineer for a company which undertook dredging operations in Italy. His first work in mechanical engineering was done in 1867, when he devoted his attention to double expansion steam engines. The first application of this system was made in 1876 on a two-cylinder compound which operated on the line from Bayonne to Biarritz. This design effected a saving of 20 per cent in fuel over the standard types and placed the inventor in the foremost ranks of locomotive designers.

The great success of the compound locomotive led to a material increase in the size of the units and to the development of three and four-cylinder compound locomotives. It became evident that the limit of size of locomotives of rigid construction, especially on lines with sharp curves, would soon be reached. In order to permit of the use of large motive power units on lines with sharp curves and light track, Mr. Mallet designed the articulated type of locomotive which was first introduced in this country on the Baltimore & Ohio and has since been adapted to use on American roads with such great success.

Among the honors conferred upon Mr. Mallet were the Schneider prize, awarded to him by the French Society of Civil Engineers in 1902, and the annual prizes of the society in 1909 and 1911. He was made a Knight of the Legion of Honor in 1885 and promoted to officer in 1905. The Institute of Mechanical Engineers of London awarded him a gold medal in 1915. He was a member of the Society of Civil Engineers of France, the Society for the Encouragement of National Industry of France, and the Franklin Institute of Philadelphia.

In addition to carrying on his engineering work, Mr. Mallet took active part in the work of the French Society of Civil Engineers from 1880 to within a few months of his death. He was editor of the Chronicle of the Bulletin of the Society, for which he wrote numerous technical notes and important memoirs. The last of these, treating of the practical evolution of the steam engine, earned for him the honors conferred by the society.

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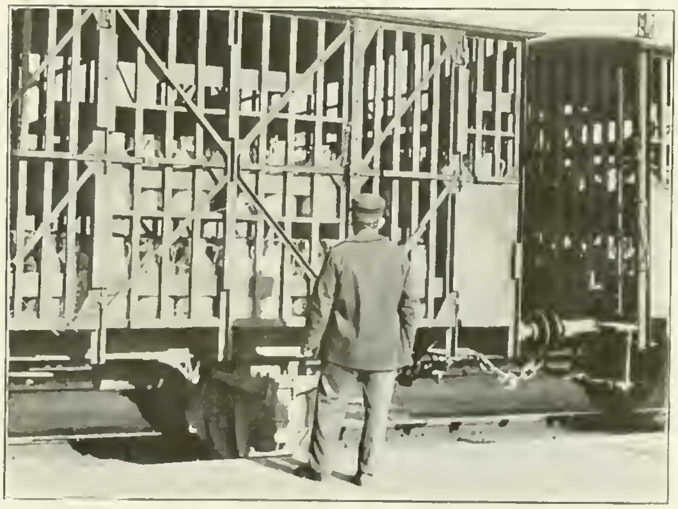


Cars with Cans of Milk Remaining Undelivered Because of the French Railway Strike

Work of the Mechanical Department in 1919

Railroad Administration Report Summarizes the Activities of the Division of Operation

The annual report of the director general of railroads for the year 1919 contains an interesting summary of the work of the mechanical department. An extract from the report of W. T. Tyler, director of the Division of Operation, follows:

In general, the work of the mechanical department has been similar to that performed during 1918, except that it has been more extensive. The organization has not been substantially changed, but has been somewhat increased over that at the close of 1918. At present it consists of Frank McManamy, assistant director, in charge of the department; George N. DeGuire, general supervisor of equipment, and George E. Dougherty, assistant general supervisor of equipment, whose duties are to supervise in a general way the condition of and repairs to locomotives and cars in railroad shops and to check up shop practices and expenditures with a view to promoting both efficiency and economy in the maintenance and operation of equipment; F. P. Pfahler, chief mechanical engineer, whose duties are to supervise the design and construction of new locomotives and cars, pass on disputed points in connection therewith, check bills for alterations or changes, handle locomotive assignments, and such other duties as may be assigned to him; J. J. Tatum, general supervisor of car repairs, whose duties are to supervise the general condition of and repairs to freight and passenger cars, see that repairs are promptly and efficiently made, and arrange for the distribution of cars as between different shops, so that the greatest efficiency may be obtained; J. R. Jackson, mechanical engineer, who in addition to the usual duties of a mechanical engineer is also in direct charge of the investigation of new inventions and appliances. In addition there is a field force of 24 men, whose duties are to make special investigations, check up methods of handling and repairing locomotives and cars, promote shop efficiency and such other special work as may be assigned; and the necessary office force consisting of 52 persons who perform the usual duties in connection with the handling of correspondence and records.

> Maintenance of equipment, labor disputes and the national agreement; safety appliances and standard practices and vocational training of railroad employees are some of the subjects discussed

The field force has been a potent factor in promoting efficiency and controlling the cost of maintenance of equipment, and the part performed by the force in the matter of assisting the work of both the locomotive and car departments on the different railroads and the consolidation of the work as between different railroads has been of real value.

No additional orders for new locomotives or cars have been placed during the year 1919, but work has been pushed on the completion and assignment of the cars and locomotives built to standardized designs which were ordered during the year 1918.

Maintenance of Equipment

During 1919 the railroads in federal operation operated 65,100 locomotives, 54,193 passenger train cars, and an average of 2,430,719 revenue freight cars.

There has been no shortage of locomotives during 1919; in fact, the increased efficiency in locomotive maintenance and operation effected by the more general use of locomotive repair facilities and by increased efficiency in handling at terminal points has resulted in a surplus of locomotives during the entire year.

Owing to the increased capacity of the locomotive repair shops there were on January 1, 1919, 1,384 locomotives in good condition in storage. On April 1 this number had increased materially. This early period of 1919 was one of light business, which rapidly changed to brisk traffic about the middle of the year.

During the period from November 1, 1918, to September 30, 1919, 43,608 locomotives were given classified repairs and 298,183 locomotives were given repairs requiring over 24 hours. Ordinarily running repairs which are required after each trip and which consume less than 24 hours are not included.

The classified repairs were in accordance with the United States standard classification, which requires certain essential repairs to be made and locomotives placed in condition to perform a specified term of service before they can receive credit for class repairs.

On January 1, 1919, there were 138,722 freight cars, which is 5.8 per cent of the total revenue cars in service at that time, in bad order. This number decreased to such an extent that on March 1, 1919, only 127,336, or 5.2 per cent, cars were in bad order.

The adjournment of Congress on March 4, 1919, without providing the appropriation requested by the Railroad Administration made it necessary to exercise the most rigid economy in maintenance of equipment expenditures; therefore car-repair forces were reduced on practically all railroads under federal control. This reduction in car-repair forces resulted in an increase in the number of bad-order cars. On June 20 instructions were issued to restore car-repair forces, but before this order could be made effective on all railroads the number of bad-order cars had still further increased. The strike of the shopmen on August 1, which, although unauthorized by the employees' organizations, resulted in large numbers of car repairers leaving their work for a period of approximately 10 days, still further increased the number of bad-order cars, until on August 16 there were 228,549 bad-order cars, which is 9.2 per cent of the total number of revenue cars.

Since that time, however, the work of conditioning freight cars has been vigorously pushed until at present there are but 127,182, or 5.1 per cent revenue cars in bad order that will be repaired. This does not include 19,300 cars set aside under the provisions of Circular 20, issued by the Division of Operation, which are in effect condemned cars which will not be repaired by the administration and are being held because the owning corporations have not agreed to their dismantling on the basis given in the master car builders' rules.

During the period from November 1, 1918, to September 27, 1919, a total of 21,080,127 freight-train cars were repaired in the shops of railroads in federal operation. During the same period 14,119 cars were repaired in contract shops, and 20 new contracts were made covering 17,600 cars to be repaired by such concerns. This illustrates the diligent efforts which were made to condition freight cars to meet the demands of the traffic.

During the period from November 1, 1918, to September 1, 1919, 417,320 passenger-train cars were given either running or classified repairs.

Immediately following the signing of the armistice instructions were issued to eliminate where practicable the overtime worked in repair shops, and employees in all shops and car-repair plants were reduced to the regular day's work of eight hours. While this of necessity resulted in a decrease in the number of cars repaired, it was only fair to employees who for many months had been faithfully working whatever hours were required of them by the administration, and the restoration of the established eight-hour day was a deserved recognition of the co-operation and faithful service rendered.

The difficulty in securing necessary material for repairs to both locomotives and cars continued for a considerable portion of 1919. Where shortages of material were found to be delaying equipment, necessary action was taken to obtain either from the manufacturers or from some other railroad the material needed to complete the work and avoid delay to equipment. This has been one of the most valuable activities of the central administration.

The work of modernizing existing equipment has not been overlooked, and in line with plans which were partially completed when the roads were taken under federal control 1,123 locomotives have been equipped with superheater since November 1, 1918, preference in all cases being given to the heavier power.

Other devices, such as stokers, power-reverse gears, power-grate shakers and similar appliances which make for efficiency and economy in locomotive operation, have been applied to the extent that the conditions under which the railroads are operated would permit.

The work of applying headlights to locomotives in accordance with the orders of the Interstate Commerce Commission has been diligently followed with the result that substantial progress has been made, and the indications all point to the fact that this work will be completed well within the time provided.

Control of Maintenance of Equipment Expenditures

From the beginning the mechanical department has diligently endeavored to maintain the equipment without any idea that economies should or could be realized by reducing maintenance which the equipment ought to receive. With this thought in mind, we began immediately after the roads were placed under federal control to check locomotive shop output and roundhouse and shop costs, so that all unnecessary expenditures might be eliminated and greater efficiency in shop and roundhouse operation obtained. Where improper practices were found to exist, action was taken through the regional directors to have more efficient methods adopted.

In order that expenditures for maintenance of equipment might be measurably controlled, federal managers were required to prepare and submit on suitable forms information regarding maintenance of equipment during the test period, during the seven years prior to the test period, as well as during the calendar year of 1918. This information was collected on the basis of the miles of roads operated, the units of equipment, and the locomotive and car miles, together with averages showing the cost of locomotive repairs separately on the basis of miles run, tractive power miles, and per locomotive owned.

Freight-car repairs were reported on the basis of 10,000 freight-car miles and freight cars owned, and the passenger-train car repairs were reported on the same basis.

From these reports studies of the maintenance of equipment costs were made and furnished to the regional directors, to keep them in touch with the actual conditions and aid them in the control of maintenance of equipment expenses.

In this work we have constantly kept before us the thought that the ability of the railroads to move present and prospective business was the first consideration, and after this requirement had been fully met reductions in maintenance expenditures which could properly be made should be made on railroads which were clearly overexpended in the matter of maintenance of equipment in comparison with the test period, but in no case has the fact that a railroad has been overexpended for maintenance of equipment been permitted to reduce maintenance to a point where it would interfere with the handling of traffic.

Analyzing and tabulating the information received from the different railroads in connection with the maintenance of equipment expenditures is going forward, so that all available data may be in shape for proper consideration when needed. This also includes the establishment of equation factors for increased cost of labor and material to enable comparisons to be made as between the test period and the period of federal control.

Damage to Cars in Yards and in Trains

During the first year of federal control it was noted that the number of freight cars damaged in yards and in trains was excessive. A careful study was made to locate the cause, and it was decided that the number of cars so damaged could be materially reduced by more careful inspection and maintenance of hand-brake equipment, and by more careful supervision over switching in yards and the operation of trains.

A comparison of the last 7 months of 1918 with the first 10 months of 1919 will show the effect of the work which was done to reduce this damage. We are able to show this information for only 7 months of 1918 because prior to federal operation such information was not generally kept, and it was not until June, 1919, that reports were obtainable from all railroads.

During the 7 months for which this information was available in 1918 there were 179,145 cars damaged in yards and 401,670 damaged in trains, a total of 580,815 cars. During the period from January to October, inclusive, 1919, there were 179,921 cars damaged in yards and 335,798 damaged in trains, a total of 515,719 damaged, which is a decrease over the previous year of 37 per cent.

The average cost per month to repair the cars damaged in 1918 was $1,779,240, which was reduced to $1,366,555 in 1919, or at the rate of an annual saving of $4,952,225.

Reducing the damage to equipment also reduces the damage to lading and permits the cars to remain in service. The reduction in freight claims and the value of cars in service can only be estimated, and therefore are not included in the above saving.

It would be exceedingly profitable for the railroads, after their return to private control, to continue a careful check of the damage to cars in yards and in trains and to establish a closer supervision over switching and train handling.

Committee on Standards

The present committee on standards was created as of July 1, 1918, for the purpose of carrying forward and completing the work of the original committee which designed the locomotives and cars, and which on account of other important duties of many of the members of that committee could not be continued.

In addition to completing the work started by the original committee, this committee has been called on to pass on various devices and methods used on locomotives and cars, as well as methods or devices intended to facilitate repairs and improve operation which were submitted under Circular 18. The committee has also been called on to act in an advisory capacity in the general activities of the mechanical department, including the preparation of specifications for new equipment, tests of material, and maintenance of equipment, as well as in connection with the use of numerous patented articles submitted for the use of the Railroad Administration.

The work of this committee in establishing standards for maintenance as well as for new equipment has been extremely valuable, and has made possible economies in the mainte-

nance of equipment and has reduced the delay to cars on repair tracks by providing a standard which could always be used without waiting to send to the home road for necessary materials to make repairs in kind. This committee has also been called on to investigate and pass on various methods or appliances essential for the promotion of safety in locomotive or train operation.

In order to handle the large number of inventions and devices to be used on or in connection with locomotives and cars, a committee on appliances, which is really a sub-committee of the committee on standards, was created. The work of this committee consists of investigating all inventions or devices submitted to the Railroad Administration in accordance with Circular 18 for use or for test; eliminating those that were clearly impracticable or unsuitable; making investigations of the results of the tests conducted by the various railroads of the different appliances, and submitting to the committee on standards those which appear to have sufficient merit to justify further investigation.

So that all matters submitted might have uniform treatment, the rules provided in Circular 18 have been strictly followed. These rules specifically provide that arrangements for tests of any device will not be made until an examination of the plans discloses the necessity or desirability of conducting such tests under service conditions. In case such test is to be made, the appliance must be furnished, installed, and operated without expense to the Railroad Administration. This work has covered a very wide field.

A classification of the invention files as of October 1, 1919, under 12 headings, shows a total of 1,160 devices and appliances. The investigations and reports on 225 of these devices have been completed, with the exception of 14 which were recommended for service tests. Reports on 245 devices are being delayed waiting for additional information from the inventor or railroads which have used the device.

Safety-Appliance Laws

The enforcement of the safety-appliance laws, which has been handled by the Railroad Administration since the railroads have been under federal control, has been under the direction of the mechanical department. During that period 13,295 specific violations have been filed by the Interstate Commerce Commission, all of which have been handled for correction.

As provided in General Order No. 46, reports of all violations were submitted to the mechanical department. The greatest number of such violations submitted was during the month of February, 1919, when 1,970 were submitted. Since that time the number of such violations has steadily decreased, only 731 having been filed in September, which indicates that the action taken has been effective.

During this period a number of matters which have been in dispute between individual railroads and the commission for several years have been satisfactorily settled. Among these is the matter of controlling the speed of freight trains on grades without the use of hand brakes. Failure to control trains with air brakes has resulted in numerous suits being filed by the Interstate Commerce Commission. For instance, this question was taken up with the Baltimore & Ohio Railroad in 1908, since which time it has repeatedly been before the courts without a definite conclusion.

It is believed that the matter has now been settled by conference and joint investigation arranged by the mechanical department between the Bureau of Safety of the Interstate Commerce Commission and the railroad officials. At this conference an agreement was reached as to a practical method of handling trains on the various grades as required by law, and instructions were issued by the Railroad Administration putting this arrangement into effect.

Similar conferences have been arranged in connection with other matters, and by working in close co-operation with the representatives of the commission on these matters it is believed that much permanent good has been accomplished.

Action Taken to Promote Safety

In addition to the enforcement of the safety-appliance laws, an understanding was reached with the employees who in the past have been urging safety legislation, both state and national, that before such action was taken their demands would be presented to the Division of Operation for consideration, with a view to providing all necessary safety devices for the protection of the employees without the necessity of additional legislation, either state or national. Pursuant to this understanding, arrangements have been made by the mechanical department to equip locomotives with the following devices for the promotion of safety or efficiency, in addition to those required by federal laws:

Mechanical fire doors, lagging on steam pipes in cabs, standardization of location of air-brake cut-out valves in cabs; relocating air compressors so they will not obstruct the view of enginemen; applying handholds and suitable steps on sides of cabs; providing sanitary drinking water on locomotives; locating water glasses so they can be easily read by engineer and fireman, or applying second water glass if needed; applying electric marker and classification lamps; closing openings in cabs around boiler heads, injector pipes, reverse levers, etc.; providing cab heaters, equipping locomotives in cold climates with suitable cab curtains.

While these appliances are primarily in the interests of safety, they also promote efficiency and economy in locomotive operation.

Extension of Time for Applying Safety Appliances to Freight Cars

Due to the war and other causes, the application of safety appliances, as required by federal laws and orders of the Interstate Commerce Commission, had been delayed so that this important work could not possibly be completed within the time provided, although repeated extensions had been granted by the commission, the last one expiring on September 1, 1919.

Although it was suggested that an extension of time until January 1, 1921, be asked for, upon investigation made by the Railroad Administration, it was concluded that if vigorously pushed the necessary work could be completed in much less time. Therefore, a request was made to the Interstate Commerce Commission to extend this period, and after a hearing, at which the situation was presented to the commission, an extension was granted until March 1, 1920, to complete the work of equipping freight cars with safety appliances.

In order to force this work to a speedy conclusion instructions were issued that empty cars should not be accepted in interchange unless equipped with United States safety appliance standards.

This work is being closely followed, so that there may be no possibility of a further extension being needed. With the progress now being made it will be entirely practicable to withhold from service all cars not equipped prior to March 1, 1920.

Vocational Training for Railroad Employees

The plans for vocational training for railroad employees in connection with the Federal Board for Vocational Education, which were referred to in our 1918 report, have been completed, and all railroads under federal control have been authorized to co-operate with the Federal Board of Vocational Education in the establishment of training schools for apprentices.

The railroads have also been granted authority to require the attendance of apprentices at these schools not less than 208 hours per year, and to incur necessary expense to fit up suitable classrooms in which such classes may be held.

The Railroad Administration is also co-operating with the Federal Board for Vocational Education in the matter of training disabled soldiers and sailors for such work in the railway service as their physical condition will permit them to perform. Under the arrangements made with the Federal Board for Vocational Education, such men may be taken into railway shops and fitted for positions in mechanical work under a plan for special training and be paid by the railroad for their services approximately the wages of an apprentice. An additional allowance is made to such men by the Federal Board for Vocational Education, which will bring their pay somewhat higher than that of the average railway employee.

An understanding has also been reached with the employees' organizations that when these men have completed their course of training they may be employed as journeymen either in the shop where they have been trained or at any other point.

National Agreement

One of the inevitable results of federal operation of the railroads was the establishment of uniform rates of pay and working conditions for railway employees.

Under the arrangements in force when the railroads were taken over, each of the various railroad lines had its own shop rules or working agreement with the shopmen. This resulted in not only differences of rates but in working conditions on different railroads, which caused dissatisfaction and unrest among the employees and resulted in a movement of shopmen from road to road to take advantage of certain improved conditions. During the latter part of 1918 the shopmen requested consideration of a national agreement covering all railroads in federal operation, and such a proposition was submitted early in January, 1919. After consideration by various boards and committees, the matter was turned over to the mechanical department on September 11, and the negotiations with the shopmen's committee were completed on September 17; the agreement approved and signed by the director general and the executive officers of the employees' organizations on September 20, to become effective on October 20, 1919.

The director of the Division of Operation recommends the continuation of the administration's labor policy and standardization of the construction and repair of freight cars.

This agreement is in line with the labor policy of the Railroad Administration, and is an important step forward in dealing with the labor situation. It has already been demonstrated that putting the agreement into effect in a harmonious and co-operative manner has materially improved the labor situation by allaying the unrest among the shop employees which prevailed and insuring them uniform treatment and proper consideration, and improvement has already been noted in the operation of shops, engine houses and repair yards due to the more stable conditions brought about by this agreement.

An important fact developed in connection with the national agreement is that adequate provision was not being made to insure a future supply of mechanics by proper development of the apprenticeship system. At the ratio provided by the national agreement 64,159 apprentices could be employed, while a check of actual conditions shows that but 17,218 are employed. If we are to provide a future supply of skilled mechanics, more attention must be given to maintaining the full ratio of apprentices and giving them proper training.

Method of Handling Labor Disputes

During the year 163 labor disputes with shop crafts, some of them of an extremely difficult character, have been successfully handled by the mechanical department without serious inconvenience to transportation and without the necessity of referring them to the Division of Labor. We have uniformly followed the policy of absolutely fair treatment of employees, exerting every reasonable means to correct any abuses found to exist and impressing upon all concerned the necessity of handling grievances in an orderly manner and in accordance with existing agreements.

In the cases where this failed and the employees stopped work, they have been plainly told that grievances would not be considered after the employees had left the service; therefore, the only way to obtain action was to return to work and present their grievances in an orderly manner.

The success of this policy has been proven by the fact that since the railroads have been in federal operation there has not been a single strike authorized by the executive officers of the various shopmen's organizations, and we have had their co-operation to the fullest extent to promote harmony and efficiency in shop work.

One of the provisions of the national agreement is that "prior to the assertion of grievances as herein provided and while questions of grievances are pending, there will neither be a shutdown by the employer nor a suspension of work by the employees." This is an important concession by both sides which, if fairly observed, will go far toward eliminating disputes between the railroads and their employees.

Distribution of Labor

The distribution of shop labor to meet the demands in different sections of the country under varying business conditions has received careful attention.

We have considered that each skilled mechanic trained in railroad work represents a certain definite investment which is lost to the railroads if, on account of a temporary period of dull business, the man leaves railroad service to enter the employ of a private industry, because in many instances he never returns to railroad service. To avoid this loss of skilled workmen, as well as to provide employment during periods of dull business, arrangements have been made through the regional directors to provide employment within their region as far as practical for men who are laid off owing to dull business on the different railroads.

Where employment cannot be provided within their own region arrangements have been made to advise this office of all cases where there is a shortage or a surplus of skilled workmen when arrangements have been made for transfer. In this way we have been able to fill many vacancies as well as to provide employment for deserving workmen, and have thus retained to the Railroad Administration men who are skilled in mechanical work. In this we have had the close and sympathetic co-operation of the Railway Employees' Department of the American Federation of Labor, who furnish us with names of workmen seeking employment, and carefully follow up the cases where on their request workmen are sent to the different railroads to see that they accept the employment offered and for which they were furnished transportation.

It is believed that this work could be advantageously continued under private control and that it would be of decided benefit to both the railroad companies and to the workmen.

Activities of Field Men and the Saving Effected by Their Work

The work of the field forces has consisted of making special investigations of improper conditions reported, checking up conditions in shops, engine houses and repair yards for the purpose of promoting efficiency and economy in operation and handling labor matters that had not reached the stage

where they should be referred to the Division of Labor for settlement.

During the war the forces at practically all terminals had been built up to such an extent that they were out of proportion to the business handled. A check on the Erie Railroad in 1918 showed the need for a thorough investigation of shop and engine-house conditions on all railroads; therefore this work was extended and developed into a comprehensive system of reporting conditions of shop and engine-house operation monthly through the regional directors.

On account of the changed values due to increased labor and material costs, a comparison on a money basis was worthless; therefore all comparisons of shop and engine-house operation were made on a man-hour basis.

To illustrate the improvement in conditions, a check of 2,921 engine houses in January, 1919, showed an average of 30.58 man-hours per locomotive handled, while a check of the same engine houses in July, 1919, showed 25.77 man-hours per locomotive handled, or a decrease of 7,013,036 in the number of man-hours in handling approximately 54,000 locomotives. This represents a saving per month of $4,263,541, which is at the rate of approximately $50,000,000 per annum.

Other matters which have been investigated by the field forces include disputes between officials and the employees, losses due to good material finding its way into the scrap bins, shop practices and the efficient use of machine tools, storage of material to see that it is properly protected, condition of shops and shop grounds, condition of roundhouses, turntables, cinder pits and other terminal facilities to see that they were sufficient and were efficiently operated, checking up car-repair forces and facilities, and in many instances reorganizing forces at division points or on an entire railroad, seeing that shops and repair yards were properly supplied with material and tools so that the work could proceed without delay.

Distribution of Power

Through reports made each week by each railroad the mechanical department is kept informed as to the exact condition on each road with respect to motive power. This information enables us to promptly transfer locomotives from one road or section of the country to other roads or points where an actual or anticipated shortage of power develops to facilitate the movement of traffic.

In order to meet any contingency that might arise and avoid such congestion as existed in the latter part of 1917 and the beginning of 1918, 150 new Mikado and Santa Fe type locomotives were held in reserve in emergency pools at Albany, Buffalo, Cleveland, Columbus and Potomac yards. These locomotives were under the control of the mechanical department and were held for assignment to any road where, due to either adverse weather conditions or to increased volume of business, the need for additional power became apparent. From time to time locomotives as needed to tide over temporary emergencies were taken from these reserve pools and despatched to the roads or points where they were most needed. This reserve supply of locomotives was maintained until it became clearly apparent from the condition of power as well as from the demands that they would no longer be needed when the locomotives comprising the reserve were forwarded to the owning roads.

In addition to the locomotives in this reserve, 200 locomotives originally constructed for the Russian government are under the control of the administration, to be used as a power reserve, which can be promptly and easily transferred as the needs of the service demand.

The rapid development of the oil fields in the Southwest created an acute shortage of power on the roads traversing that territory, which was promptly met by the immediate transfer of power from the East, care being taken to provide locomotives to meet the clearances and restricted bridge loading in that territory.

In order to meet the increased demand for locomotives to move coal traffic a large number of locomotives were transferred to the coal-carrying roads in the Lake region during the early fall.

Approximately 750 locomotives have been constantly in service on other than owning lines. Their location has been changed from time to time to meet traffic conditions, which has enabled us to at all times furnish a sufficient supply of motive power to meet traffic conditions in the various sections of the country.

Since January 1, 1919, 2,307 locomotives have been given repairs in other than owning line shops.

A number of practices and methods established by the Railroad Administration should be permanently established and made standard because they are in the interest of economy, efficiency and uniformity.

Practices Which Should Be Continued and Made Standard

Among these is the standard classification of repairs to locomotives and tenders, because it forms a reasonably accurate basis of comparison of the work of the different shops and the cost of locomotive maintenance. It also promotes efficiency by establishing a certain definite standard for locomotive repairs, thus preventing the practice which is altogether too common of shopping locomotives at frequent intervals and doing only a portion of the work needed in order to increase the mileage between class repairs.

The standards for repairs to freight cars provided for in these circulars were established to avoid delays to freight cars when on other lines waiting for material to make repairs in kind.

On December 31, 1917, 52 per cent of the total number of freight cars were on their home lines, and at the present time less than 25 per cent of cars are on home lines, and it is extremely doubtful if this percentage will ever be materially increased, because no matter how diligent the efforts to send cars to home lines the first period of heavy business scatters them to all parts of the country, and it is months before they can again be returned to their home lines. For this reason the standardization not only of construction but of repair parts is a necessity if we are to properly maintain equipment at a reasonable cost.

In the interest of efficiency and economy individual standards of freight-car construction or repairs should never again be permitted, as there is not a logical argument that can be advanced in opposition to the standardization of freight cars on all roads.

For the above reasons the standards for repairs established by circulars 7 and 8 should be continued subject to necessary revision from time to time, and should be added to wherever it may be found pratical to do so.

The inspection of stationary boilers by the railroads should be continued under their own supervision, thus insuring the very best possible character of inspection, and that inspections will be made at times when it will cause the least inconvenience.

This method of inspection will also promote efficiency and bring about uniformity in the different requirements, so that railroads operating through several states will not have a number of different standards of inspection for their stationary boilers.

Complete records of the standardized equipment constructed by the Railroad Administration, including drawings and prints, cost of maintenance as developed by special investigations or otherwise, and all other matters covered by this report or handled by the mechanical department, are available in our files for use when needed.

The Effect of Molybdenum in Alloy Steels

Increased Toughness and Wide Hardening Range Characterize Steels Containing This Element

In the development of modern railroad equipment the excessive size of parts required to bear the high stresses is often a limiting factor. The use of alloy steels has been recognized as a possible method of overcoming these limitations, but the results secured with this material have not been wholly satisfactory.

The requirements of a steel for use in the running gear of a locomotive are (1) toughness and ability to resist sudden and repeated shocks, (2) ease of manipulation, to permit of handling it without installing special equipment. In addition, it is desirable that the steel have a high elastic limit and ultimate strength. The low carbon steels used in ordinary forgings meet the first requirements, but are deficient in strength. The majority of alloy steels have desirable physical properties, but require special care in working and cannot readily be handled in railroad shops. In view of these facts, it is interesting to note that steels alloyed with molybdenum, which seem to combine in an unusual degree the properties that have been found desirable for steels used in locomotives, are now being introduced for railroad service.

The properties of molybdenum steels are set forth in a book recently issued by the Climax Molybdenum Company, New York, from which the information in this article has been secured. The data presented are stated to be the results of tests of the ordinary commercial steels taken from the records of the users of these alloys.

The use of molybdenum as an alloy agent in steel was developed commercially under the stress of war conditions. The properties which made molybdenum alloys especially valuable for use in liberty motors, tanks and other equipment subjected to severe stresses are the high tensile strength and high elastic limit, combined with unusually large reduction of area secured by its use. Other incidental advantages are the wide range of temperature within which the tempering and drawing operations can be performed without greatly altering the physical properties of the steel, the uniformity of hardening throughout large sections, the reduction of warpage during manufacture and the unusual toughening of the steel.

The relatively small variation in the physical properties which results from a change in the quenching temperature is well illustrated by the following results secured with a chrome molybdenum steel:

Tensile Test, Physical Properties, Grade MO-2 Chrome-Molybdenum Steel

Water quench	Elastic limit	Tensile strength	Elongation, per cent	Reduction of area, per cent
1,500 deg. F.	149,600	162,900	16.0	57.2
1,550 deg. F.	151,000	163,400	16.5	57.3
1,600 deg. F.	148,800	163,600	17.0	57.3
1,650 deg. F.	148,500	161,400	16.5	58.9
1,700 deg. F.	149,500	162,400	16.5	56.8

Tests made on 1¼-in. round bars, all drawn at 1,000 deg. F. Analysis: carbon .23 to .30, manganese .50 to .80, chromium .80 to 1.10, silicon .10 to .20, molybdenum .25 to .40.

This is further illustrated by the photomicrographs in Fig. 1. The uniformity of hardening throughout large sections is shown by Fig. 2, in which the Brinell readings on 3½-in. square sections of chrome-molybdenum and another similar alloy steel are compared.

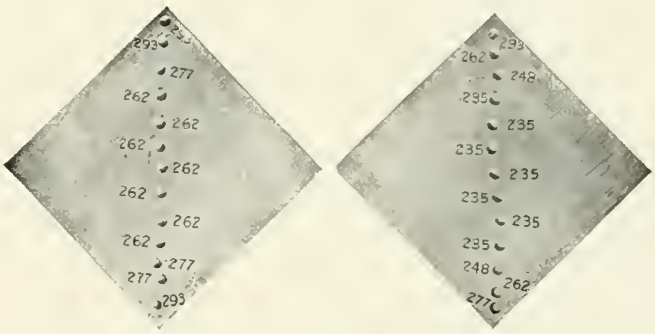
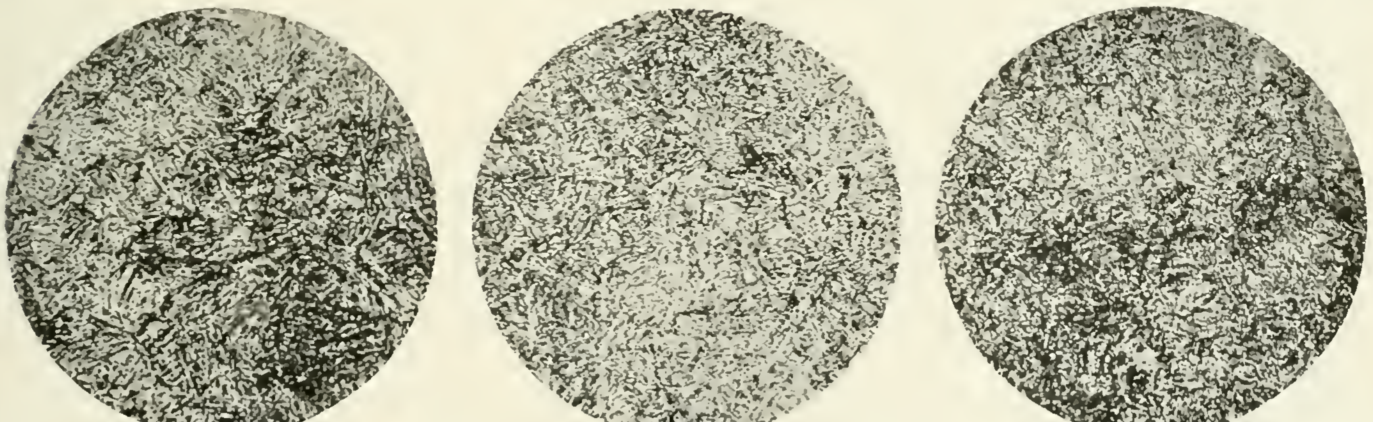


Fig. 2. Comparative Brinell Hardness of Chrome Molybdenum Steel (shown on the left) and a Similar Alloy Steel

Molybdenum has been used for many years in the manufacture of high-speed steel with six per cent of molybdenum and came into disuse with the tool steel trade because the composition was unfavorable to uniform results after redressing the tool. This defect was accounted for by volatilization, but at the present time molybdenum tool steels are being produced in Great Britain and here in commercial tonnages, with cobalt as a satisfactory stabilizer. All of the steels described



Drawn at 700 Deg. F. — Drawn at 1,100 Deg. F. — Drawn at 1,300 Deg. F.

Fig. 1. Microphotographs of Chrome Molybdenum Steel Showing Similarity of Microstructure at Various Drawing Temperatures

Specimens quenched in oil from 1,600 Deg. F. and drawn as shown. Magnification 400 diameters

in this article contain molybdenum in amounts ranging from .3 to .8 per cent. In these steels there is no volatilization in production or in use. Heretofore, the properties imparted by fractional percentages of the element were relatively little understood and the alloys of molybdenum formerly used were often impure and the results secured were therefore not uniform. Furthermore, molybdenum was classed as a rare element, not available in commercial quantities.

During the war large deposits of molybdenum were developed at Climax, Colo. From this ore ferro-molybdenum and calcium molybdate were produced in quantities, and a large tonnage of various types of molybdenum steel was manufactured. The molybdenum is introduced into the steel either in the bath or in the ladle, preferably in the bath, and can be used in steels produced by the open hearth, electric or crucible process.

The alloys which have been developed thus far are of four general types, chrome-molybdenum, chrome-nickel-molybdenum, nickel-molybdenum and chrome-vanadium-molybdenum steels. Each of these alloys is made in a number of grades

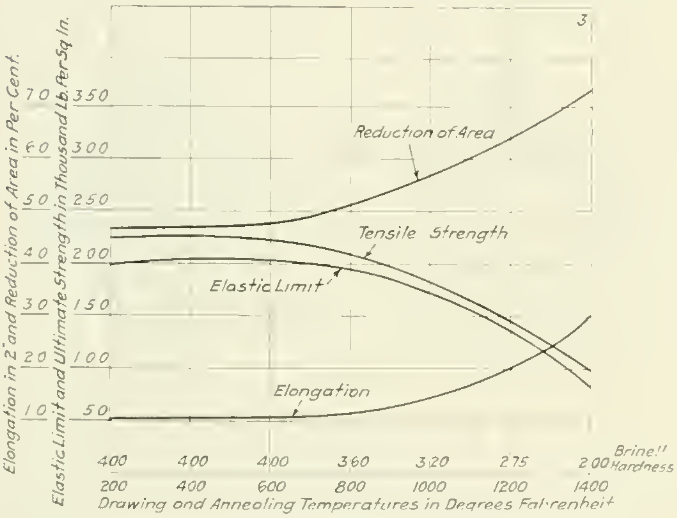


Fig. 3. Properties of Chrome Molybdenum Steel Quenched in Water and Drawn at Various Temperatures

All tests made with 1¼-in. square bars quenched from 1,600 deg. F. Hardening range 1,500 to 1,700 deg. F. Bars heat treated in full size, then machined to .505 in. diameter. Approximate average analysis: carbon .32 per cent, manganese .55 per cent, silicon .15 per cent, chromium .90 per cent, molybdenum .37 per cent.

with varying percentages of the metallic elements and varying carbon content. The chemical compositions are as follows:

Chrome-Molybdenum Steels

Type MO

	Per cent
Carbon	.15 to .40
Manganese	.40 to .80
Chromium	.70 to 1.10
Molybdenum	.25 to .40

Type MS

Carbon	.40 to .50
Manganese	.60 to .90
Silicon	.10 to .20
Chromium	.80 to 1.10
Molybdenum	.25 to .40

Chrome-Nickel-Molybdenum Steel

Type LM

Carbon	.25 to .35
Manganese	.50 to .80
Silicon	.10 to .25
Chromium	.70 to 1.00
Nickel	2.75 to 3.25
Molybdenum	.30 to .50

Nickel-Molybdenum Steel

Type NM

Carbon	.20 to .40
Manganese	.30 to .50
Nickel	3.00 to 5.00
Silicon	.10 to .20
Molybdenum	.30 to .70

Chrome-Vanadium-Molybdenum Steel

Type VM

Carbon	.30 to .40
Manganese	.40 to .60
Chromium	.70 to 1.00
Vanadium	Trace to .17
Molybdenum	.35 to .85

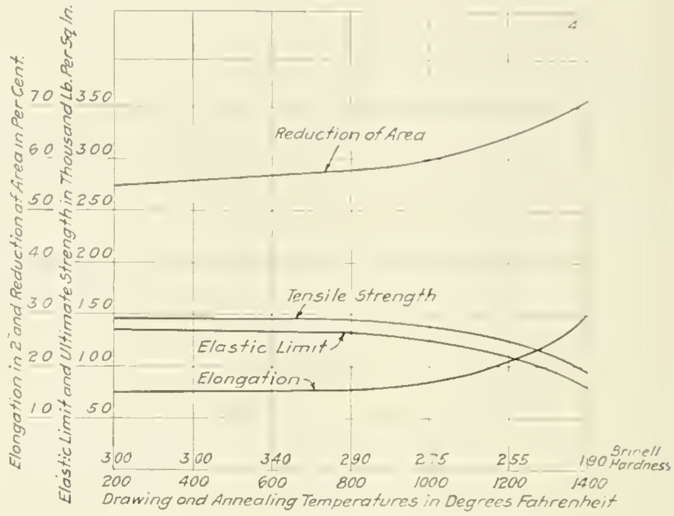


Fig. 4. Properties of Chrome Molybdenum Steels Quenched in Oil and Drawn at Various Temperatures

Method of testing and average analysis same as given in Fig. 3, except quenching temperature, which was 1,700 deg. F.

Properties of Chrome-Molybdenum Steel

The steels of the chrome-molybdenum series are made in four grades of varying carbon content, the analyses being as follows:

Type MO

(Molybdenum .25 to .40 per cent)

	Grade MO-1	Grade MO-2	Grade MO-3
Carbon	.15 to .23	.23 to .30	.30 to .40
Manganese	.40 to .70	.50 to .80	.50 to .80
Chromium	.70 to 1.00	.80 to 1.10	.80 to 1.10
Silicon	.10 to .20	.10 to .20	.10 to .20

Sulphur and phosphorus each .04 maximum.

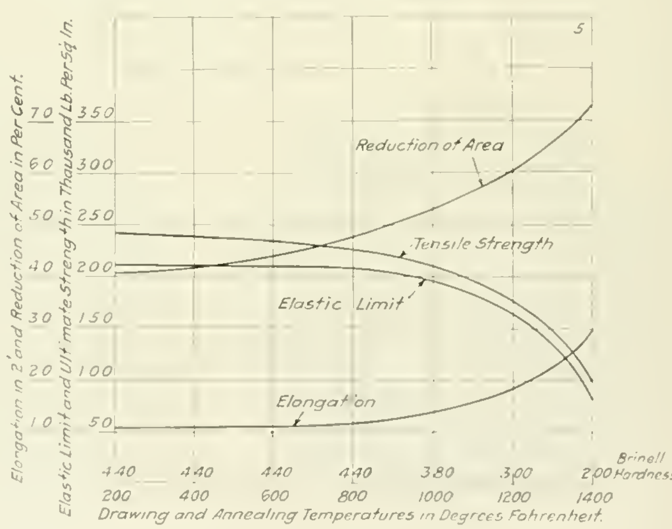


Fig. 5. Effect of Higher Molybdenum Content on Chrome Molybdenum Steel, Water Quenched

Approximate average analysis: carbon .36 per cent, manganese .52 per cent, silicon .13 per cent, chromium 1.00 per cent, molybdenum .76 per cent. Method of testing same as given in Fig. 3. Hardening range 1,500 to 1,700 deg. F.

This type is suitable for general machinery parts subjected to high stresses. With low carbon content it makes an extremely tough case-hardening steel, while the grades having higher carbon percentage are used principally for oil-quenched gears and large forgings. The grade MO-3 is rec-

ommended for driving axles, main and side rods, piston rods and crank pins. The properties developed by water and oil-quenching are shown by the diagrams reproduced in Figs. 3 and 4. The reduction of area, which is an index of the toughness and satisfactory machining qualities of the steel is unusually high. It will also be noted that the tensile strength

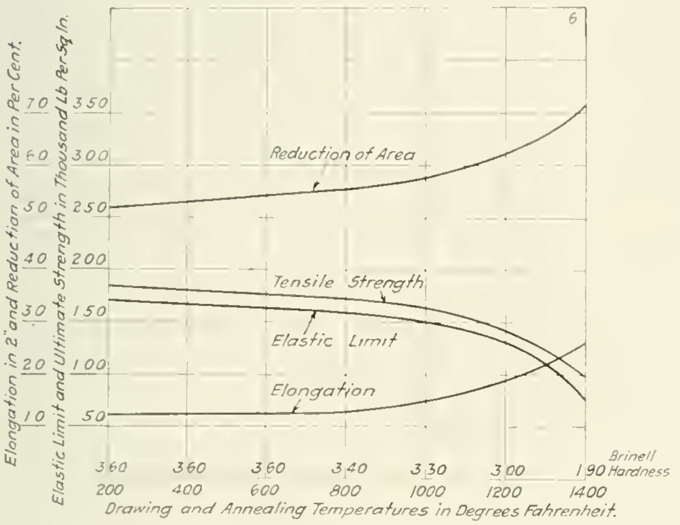


Fig. 6. Effect of Higher Molybdenum Content on Chrome Steel, Oil Quenched

Approximate average analysis same as given in Fig. 5. Method of testing same as Fig. 4.

and elastic limit decrease slowly as the drawing temperature is increased. This is a distinct advantage, as the high drawing temperature gives greater resistance to dynamic stresses or fatigue and the slow falling off of the physical properties gives a greater permissible range in heat treatment.

The effect of an increase in the molybdenum content is shown by a comparison of the test in Figs. 3 and 4 with

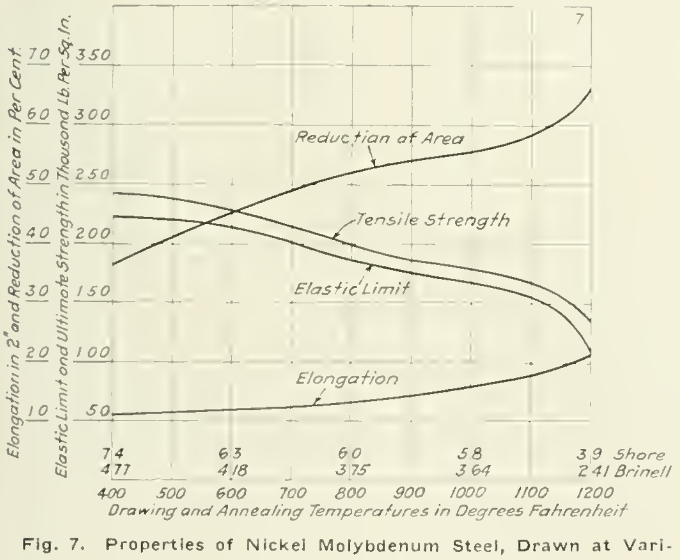


Fig. 7. Properties of Nickel Molybdenum Steel, Drawn at Various Temperatures

All tests made with 1⅛-in. round bars quenched in oil from 1,500 deg. F. Hardening range 1,450 to 1,650 deg. F. Heat treated in full size and then machined to .505 in. diameter. Approximate average analysis: carbon .33 per cent, manganese .25 per cent, silicon .18 per cent, nickel 4.50 per cent, molybdenum .58 per cent.

Figs. 5 and 6, the curves of the latter charts representing tests of steel containing .76 per cent molybdenum, whereas Figs. 3 and 4 were plotted for steel with .37 per cent molybdenum.

Molybdenum Spring Steels

The type MS has a higher carbon content than the type MO and is designed especially for springs, rivet sets and forging dies. The analysis range is as follows:

Carbon	.35 to .60 per cent
Manganese	.60 to .90 per cent
Silicon	.10 to .20 per cent
Chromium	.80 to 1.10 per cent
Molybdenum	.25 to .40 per cent

The physical properties of this steel are:

Elastic limit	180,000 to 210,000 lb. per sq. in.
Tensile strength	200,000 to 230,000 lb. per sq. in.
Elongation, per cent	12 to 15
Reduction of area, per cent	37 to 45

The chrome-nickel-molybdenum and chrome-vanadium-molybdenum steels are not considered commercially applicable for railroad service. However, the nickel-molybdenum steels are applicable for practically the same service as the type MO-3.

Nickel-Molybdenum Steels

The addition of molybdenum to nickel steel increases the elastic limit and the toughness and ductility for given elastic limits. It also permits of heat treating the steels within a wider temperature range without a detrimental effect on the physical properties.

The grade recommended for axles and similar parts is the NM-2, which has the following chemical composition:

Carbon	.30 to .40 per cent
Manganese	.25 to .45 per cent
Nickel	3.00 to 5.00 per cent
Silicon	.10 to .20 per cent
Molybdenum	.30 to .70 per cent

The table below shows the slight variation in the properties caused by marked differences in the quenching temperatures.

Table I—Physical Properties

Oil quench	Elastic limit	Tensile strength	Elongation, per cent	Red. of area, per cent
1,450 deg. F.	164,600	173,800	16.0	53.4
1,500 deg. F.	166,500	176,000	15.5	55.3
1,550 deg. F.	165,100	175,000	15.5	54.0
1,600 deg. F.	164,900	173,300	15.5	55.6
1,650 deg. F.	166,000	174,400	15.0	55.0

Analysis: Carbon .33 per cent, manganese .25 per cent, silicon .18 per cent, nickel 4.50 per cent, molybdenum .58 per cent.

The effect of a variation is the drawing temperature is illustrated in Fig. 7.

The data presented in the foregoing charts and tables have been taken from tests of material used in automobiles, aviation engines and tanks, the sections in all cases being relatively small. The difference in the service conditions encountered in railroad equipment and the larger sections used, make it difficult to predict the behavior of molybdenum steels in locomotive parts. From the results already secured the types described above appear to have properties that would make them well adapted for use under severe service conditions and the results of the introduction of this type of alloy steel will therefore be of great interest.

A Centrifugal System of Casting Pipes.—The National Iron Corporation, of Toronto, is casting iron pipes by a centrifugal system, devised by a French engineer, which it is claimed will revolutionize the pipe-making industry by reason of the fact that it produces a stronger pipe and one that will not burst under a high pressure. The iron, at very high temperature, is poured into a trough, which is immediately introduced into a revolving water-cooled mould and turned over. Centrifugal force distributes the metal evenly, and as graduated ladles are used there is no waste. The finished pipe is withdrawn a few seconds after the iron is poured. Tests indicate greater strength and closer texture than result from the ordinary casting in sand.—*The Engineer, London.*

INERTIA FORCES OF THE REVOLVING AND RECIPROCATING PARTS IN AN ATLANTIC TYPE LOCOMOTIVE

BY EDWARD L. COSTER
Assoc. Am. Soc. M. E.

In the following calculations is presented in detail a determination of the horizontal and vertical disturbing forces exerted on the main crank pins at the dead points and quarters, respectively, by the inertia of the reciprocating parts, the main rods and the side rods of a recently built heavy Atlantic type superheated steam locomotive, having 23½-in. x 26-in. cylinders, 80-in. drivers, and 205-lb. boiler pressure, and in which, as the result of very careful design and the use of heat-treated steel, the weights of these parts have probably been reduced approximately to the minimum consistent with the requisite strength.

Denoting the front and back dead points by *F* and *B*, respectively,

Let s = piston strike in inches
D = driving wheel diameter in inches
R = crank radius in feet
L = length of the main rod, center to center, in feet
X = distance of the center of gravity of the main rod from the crank pin center in feet
k = radius of gyration of the main rod about the axis of the crosshead pin in feet
W = weight of the reciprocating parts in pounds
W' = weight of the main rod in pounds
W'' = weight of the main rod at the center of the crank pin in pounds
W''' = weight of the side rod at the center of main crank pin in pounds
W_m = counterweight at crank radius in the main driver for the reciprocating parts, main rod and the main pin end of the side rod in pounds
W_f = counterweight at crank radius in the front driver for the reciprocating parts in pounds
P_f = inertia of reciprocating parts at F in pounds
P_b = inertia of reciprocating parts at B in pounds
P_f' = horizontal inertia of main rod at F in pounds
P_b' = horizontal inertia of main rod at B in pounds
C''' = centrifugal force of W''' in pounds
C_m = centrifugal force of W_m in pounds
C_t = centrifugal force of $(W_m + W_f)$ in pounds.

For the locomotive under consideration, the dimensions and weights are as follows:

$s = 26$ in.	$W = 730.5$ lb.
$D = 80$ in.	$W' = 720.0$ lb.
$R = 1.083$ ft.	$W'' = 440.5$ lb.
$L = 11.323$ ft.	$W''' = 231.0$ lb.
$X = 4.395$ ft.	$W_m = 977.5$ lb.
$k^2 = 64.974$ ft. (approximately).*	$W_f = 306.0$ lb.

Then substituting feet for inches for the quantities within the braces of formulae (2a), (3a), (6a) and (7a), given in the writer's article entitled the Longitudinal Disturbing Forces in Locomotives,† published in the *Railway Mechanical Engineer* for July, 1919, at diameter speed we have:

$$P_f = 1.6 \times 730.5 \times 26\left\{1 + \frac{1.083}{11.323}\right\} = 30{,}388.8 \times 1.096 = 33{,}306 \text{ lb.}$$

$$P_b = 1.6 \times 730.5 \times 26\left\{1 - \frac{1.083}{11.323}\right\} = 30{,}388.8 \times 0.904 = 27{,}471 \text{ lb.}$$

$$P_f' = 1.6 \times 720 \times 26 \left\{1 + 1.083\,\frac{2 \times 4.395 - 11.323}{11.323^2}\right\} = 29{,}952 \times 0.979 = 29{,}323 \text{ lb.}$$

$$P_b' = 1.6 \times 720 \times 26 \left\{1 - 1.083\,\frac{2 \times 4.395 - 11.323}{11.323^2}\right\} = 29{,}952 \times 1.021 = 30{,}581 \text{ lb.}$$

From formula (1a) in the article above referred to, at diameter speed:

$$C''' = 1.6W'''s = 1.6 \times 231 \times 26 = 9{,}610 \text{ lb.}$$
$$\text{and } C_t = 1.6(W_m + W_f)s = 1.6(977.5 + 306) \times 26 = 53{,}394 \text{ lb.}$$

*The period of oscillation of this main rod about the axis of the crosshead pin has not as yet been determined. The value of k^2 here given is that of a rod of equal length and almost identical position of mass center, for which k^2 was calculated by the writer from the results of an oscillation test .

†These formulae were stated as follows, except that for convenience the weight designations have been changed in this article:

$$(2a):\ P_f = 1.6Ws\left\{1 + \frac{R}{L}\right\};\quad (3a):\ P_b = 1.6Ws\left\{1 - \frac{R}{L}\right\};$$

$$(6a):\ P_f' = 1.6W's\left\{1 + R\frac{2X - L}{L^2}\right\}\quad (7a):\ P_b' = 1.6W's\left\{1 - R\frac{2X - L}{L^2}\right\}$$

Therefore at 80 miles an hour the total horizontal inertia forces on the main crank pin are:

$$P_f + P_f' + C''' = 33{,}306 + 29{,}323 + 9{,}610 = 72{,}239 \text{ lb. at F}$$
$$P_b + P_b' + C''' = 27{,}471 + 30{,}581 + 9{,}610 = 67{,}662 \text{ lb. at B}$$
$$\text{Difference} = 4{,}577 \text{ lb.}$$

Consequently the unbalanced longitudinal inertia forces are:

$$P_f + P_f' + C''' - C_t = 72{,}239 - 53{,}394 = 18{,}845 \text{ lb. at F}$$
$$P_b + P_b' + C''' - C_t = 67{,}662 - 53{,}394 = 14{,}268 \text{ lb. at B}$$
$$\text{Difference} = 4{,}577 \text{ lb.}$$

Turning now to the quarters, as demonstrated in Henderson's "Locomotive Operation," 2d edition, pages 51-57 and page 516 (this discussion is too long for inclusion here), at diameter speed the resultant vertical upward and downward force in pounds exerted on the main crank pin at the top and bottom quarters, respectively, by the inertia of the reciprocating parts and the inertia and weight of the main and side rods is

$$R = 1.6s\left\{W'\left(\frac{k^2}{L^2} + \frac{\frac{X}{L}R^2}{L^2 - R^2}\right) + W\frac{R^2}{L^2 - R^2}\right\} + C''' \mp (W'' + W''')$$

the negative and positive signs preceding the last term corresponding to the top and bottom quarters, respectively.

Substituting the above given values, then at 80 miles an hour:

$$R_t = 1.6 \times 26\left\{720\left(\frac{64.974}{11.323^2} + \frac{\frac{4.395}{11{,}323} \times 1.083^2}{11.323^2 - 1.083^2}\right) + 730.5\,\frac{1.083^2}{11.323^2 - 1.083^2}\right\}$$
$$+ 9{,}610 - (440.5 + 231) = 15{,}549 + 9{,}610 - 671.5 = 24{,}487.5 \text{ lb. at the top quarter.}$$

and

$$R_b = 15{,}549 + 9{,}610 + 671.5 = 25{,}830.5 \text{ lb. at the bottom quarter.}$$

The difference of 1,343 lb. between the top and bottom quarters results from the weights of the main and side rods at the main crank pin.

Since at this speed

$$C_m = 1.6W_m s = 1.6 \times 977.5 \times 26 = 40{,}664 \text{ lb.,}$$

at the top quarter the net increase in the static wheel pressure (34,000 lb.) of each main driver, or the "dynamic augment," is

$$C_m - R_t = 40{,}664 - 24{,}487 = 16{,}177 \text{ lb.,}$$

and at the bottom quarter the net decrease in the static wheel load is

$$C_m - R_b = 40{,}664 - 25{,}830 = 14{,}834 \text{ lb.}$$

This is a total variation of 31,011 lb. per semi-revolution.

While the maximum speed of this locomotive is supposed to be 70 miles an hour, it has been operated at considerably higher velocities, hence the assumption of 80 miles an hour as a basis for the calculation of the maximum inertia forces is not excessive.

The foregoing figures indicate that, even with the most refined design and the use of the best materials now obtainable, the maximum disturbing forces at the dead points and quarters due to the inertia of the reciprocating parts, main and side rods are of great intensity, and they emphasize the vital importance of the most careful design and construction of these parts in order that their weight may be reduced to the practical minimum. For many years this fact has been universally recognized in Europe, but in this country, with a few notable exceptions, of which the locomotive here considered is one of the best examples, it has not received the attention which it unquestionably deserves.

CRANE HOOKS, depending from large traveling cranes in machine shops, ought to be painted white, so as to be easily seen. With this improvement in visibility workmen will be less likely to run against a hook or to be struck by one which is moving. This point is brought out in "National Safety News" No. 318.

CAR DEPARTMENT

A SELF-CLEARING HOPPER CAR BUILT EXCLUSIVELY FOR GRAIN SERVICE

In the construction of freight cars there is apparently a tendency to adapt them to carrying a wide variety of lading. It is therefore interesting to note that the Canadian Pacific has recently built a large capacity hopper car which is designed to handle but one commodity, grain. This car was constructed to determine by actual service test the net advantages to be obtained from a grain-tight self-clearing car of maximum tonnage capacity, as compared to standard box cars of ordinary capacity.

The limiting tonnage adopted as the basis of the design is the maximum capacity of four M. C. B. axles having 6-in. by 11-in. journals. The length was determined by the distance from center to center of unloading hoppers in the modern elevators at Montreal and West St. John, there being one elevator having hopper centers spaced 48 ft. The height was determined by the actual cubic space required to contain the full load of wheat, plus an allowance of at least 12 in. on top to permit of full load being placed in the car without trimming. To meet this condition it was necessary to make the height at the eaves 13 ft. The width at the eaves is 10 ft. 3 in.

Canadian Pacific 75-Ton Hopper Grain Car

The car is all-steel, with the exception of the running board and the ridge on top of the center sill. The general design is practically the same as is commonly used for coal cars of equal capacity, except that this car is built with a steel roof. The roof is provided with three hatch openings on each side of the running board, which are located respectively at the center of the car and directly above the two-end hoppers.

The hoppers are arranged four on each side of the center sill. The hopper openings are purposely made relatively small and the frame and slides are machined and carefully fitted. The slides are opened and closed by a rack and pinion arrangement and are locked by means of a sealing pin passing through the slide and hopper frame. The trucks are of the Vulcan type built to U. S. R. A. dimensions. The light weight is 59,700 lb., making the allowable load limit 150,000 lb.

The car having given satisfactory performance on its initial trip between Port McNicoll, Ontario and Montreal, it has been placed in regular service between the same port and West St. John. If this type of car proves suitable for grain service it will effect a large saving by eliminating leakage and doing away with the use of grain doors and coopering material.

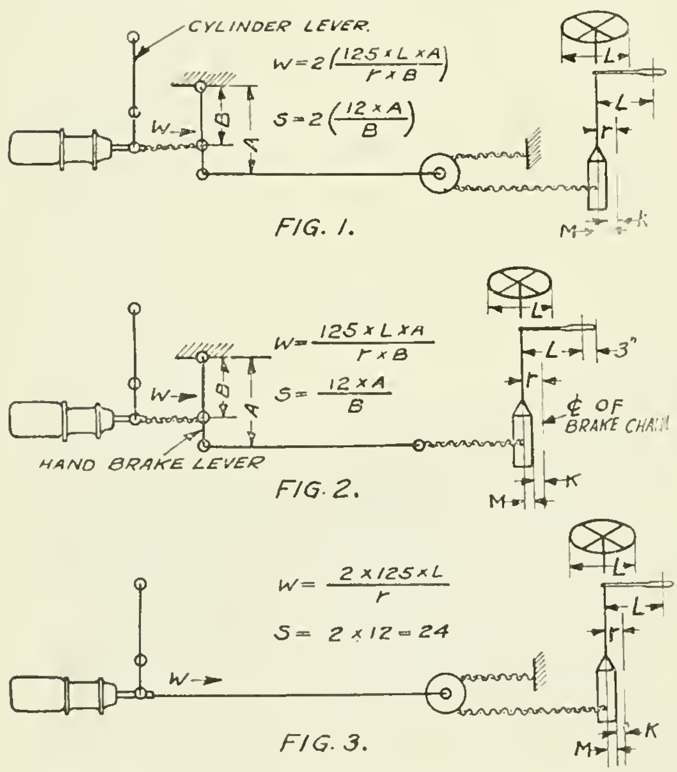
THE EFFICIENCY OF HAND BRAKES

BY GEO. L. FOWLER

Circular No. S III-11, issued by the American Railroad Association, Section III—Mechanical, in May, 1919, reads in part as follows:

"An eight inch brake cylinder has a value of practically 2,500 lb. at 50 lb. pressure and the value of a 10-in. cylinder at 50 lb. pressure is for all practical purposes 3,950 lb., and all parties concerned should use these cylinder values as a basis in proportioning the levers in the air brake system for the percentage of braking power recommended for the air brake.

"With the body and truck levers properly proportioned for 60 per cent braking power, as specified in the foregoing, and based on the formulae and diagrams shown herein, the hand brake wheel or hand brake ratchet lever, brake staff at chain, and the hand brake leverage between brake staff and cylinder shall be so proportioned that a force of 125 lb.



W = equivalent pull in lb. at brake cylinder piston rod.
125 = assumed lb. pull on rim of brake wheel, or on hand brake lever 3 in from outer end.
L, Y, A, & B = Dimensions in inches.
r = M + K.
M = radius, in inches, of brake staff drum.
K = distance, in inches, from face of brake staff drum to center line of brake chain. for 7/8 in. brake chain K = ½ in.
S = minimum chain slack, in inches, to be taken up on brake staff.
12 = piston travel in inches.
Note:—Dimension B not to be less than 11 in.

Formulae for Calculating Hand-Brake Power Given in Circular SIII-11

at the rim of the brake wheel or three inches from outer end of hand brake ratchet lever will develop an equivalent load *W* at the brake cylinder piston of not less than 2,500 lb. and 3,950 lb. respectively for cars having eight inch and 10-in. cylinders. This will insure a minimum hand brake power at the shoes of 60 per cent of the empty car weight.

"A single sheave wheel applied to end of hand brake rod should be treated as two-to-one lever in figuring the hand brake power."

These statements are apt to create a wrong impression if allowed to stand at their face value without question. The purpose of the circular is to give a method of calculating the actual brake shoe pressures to be obtained and in its presentation two assumptions are made with which the writer cannot agree. Upon these assumptions depends the whole value of the calculations for the determination of brake shoe pressures.

The first is that a pull of 125 lb. on the brake wheel should be used as the power available for the application of the brakes. That this can be done there is no doubt, but the writer has found in his investigations that a man weighing from 150 lb. to 160 lb. cannot be depended on to pull more than 75 lb. or 80 lb. on the brake wheel. A fair rough estimate of what a man can pull is one-half his weight, so that to pull 125 lb. would mean either the use of a club or that the work would be done by a man of more than ordinary strength or weight.

Then it assumes that the efficiency of the brake rigging is 100 per cent. A few years ago the writer had occasion to make a series of brake tests in which it was desired to maintain a constant pull on the brake chain of 450 lb. A dynamometer with an electrical contact was placed in the chain and so arranged that a bell would be rung and kept ringing so long as a pull of 450 lb. was maintained. An increase or decrease of pull broke the circuit and the bell stopped ringing. It was noticed that the apparent exertion which the motorman put on his work varied greatly though the chain pull remained constant. A dynamometer was then put on the brake handle and it was found that the pull required to exert a stress of 450 lb. on the chain varied from 35 lb. to 56 lb. and once after it had required 55 lb. to produce the 450-lb. chain pull, the pull on the brake handle was relaxed to 40 lb. without any decrease in the pull on the chain.

Later, in tests with a high grade geared hand brake its efficiency was found to range from 70 to 80 per cent and that of the plain staff brake to be rarely over 60 and often as low as 50 per cent. From this it is evident, that it will be quite out of the question to realize the full value obtained by the calculations in the circular. The only value of the calculations is that by the use of the original 125-lb. pull a theoretical result can be obtained which may be discounted down to that actually reached.

Then the circular states that "a single sheave wheel applied to the end of hand brake rod should be treated as a two-to-one lever in figuring hand brake power."

A number of tests have shown this to be quite wrong. The frictional resistance of an ordinary cable chain running over a sheave in the usual condition accounts for fully 25 per cent of its theoretical efficiency.

On the basis of these figures and observations, the original 125-lb. pull on the brake wheel should be reduced to 75 lb. The efficiency of the brake staff should be reduced from 100 to 60 per cent and that of the sheave to 75 per cent. Taken as a whole, the combination loses 40 per cent in basic pull, 30 to 40 per cent in the brake staff and 25 per cent for the sheave, with the result that the ultimate stress applied to the cylinder lever is only about 27 per cent of that calculated on the assumption of a 125-lb. pull. If no reduction is allowed for at the brake wheel, the actual stress applied to the cylinder lever will be about 70 per cent of that calculated with a single pull chain and about 52.5 per cent with a sheave. Of course it may be possible to make a staff that will give better results but the average as they are found will not be above these figures.

The figures given should not be set up as a final basis because of the small number of tests upon which they rest, but they are sufficient at least to prescribe caution in suggesting or accepting any theoretical basis for the calculation of the results that may be expected from hand brakes until better workmanship obtains in their construction and we know something about the efficiency of that better construction.

New Electric Cars Built for British Line

Increased Traffic Taxes Facilities; Seating and Poor Arrangements Expedite Passenger Movement

BY FREDERICK C. COLEMAN

THE Metropolitan Railway of London owns or is responsible for the operation of about 88 miles of railroad line in London and the vicinity. Of this 36 miles are electrically operated and the remainder is operated by steam. The steady increase in traffic on these lines has made it necessary to design the passenger equipment so that the stops at stations may be reduced to a minimum time. All of the company's rolling stock is in use, and a considerable addition to the equipment is necessary, as it is only with the greatest difficulty that opportunity is found to take trains into the shop for necessary overhauling and repairs.

To meet the needs of the service, new designs of cars have been worked out by C. Jones of Neasden, the chief electrical and locomotive engineer of the Metropolitan Railway, and trains composed of such cars have given very satisfactory service for several months past.

The new cars, as illustrated in the accompanying drawings and photographs, were built by the Metropolitan Carriage, Wagon & Finance Company, Ltd., of Saltley, Birmingham, England. Each train consists of a motor-car 51 ft. 6 in. long over end posts, with a seating capacity of 41 passengers, a third-class trailer car, 50 ft. 6 in. long, with a seating capacity of 58 passengers, and a first-class driving trailer car which usually operates as a trailer but has a drawing compartment and motor truck at one end. This car is 51 ft. 6 in. in length, with a seating capacity for 47 passengers. The total seating capacity of these three coaches is 146, and when working as a six-vehicle train, as they frequently are, the seating capacity is 292, as against 268 seats in a train of the older types of electric rolling stock. The feature of the new vehicles is the provision of five swing doors on each side of the cars in place of the two or three sliding doors now most generally used on electric railway rolling stock, and it is confidently expected that there will be a considerable improvement in entraining and detraining facilities.

The underframes and trucks are identical with those of the existing coaches of the Metropolitan Railway. The wheels have a diameter of 3 ft. 2 in., and the truck wheel-base is 7 ft. The new door and seating arrangements allow of improved circulation inside the cars; the inconvenience occasioned to seated passengers by others entering and leaving in the older designs is now eliminated, all gangways being

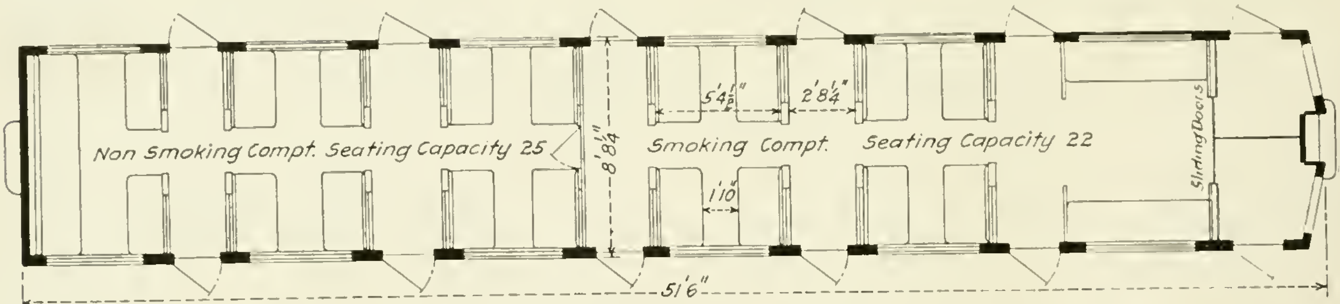
Interior of Third Class Trailer Car

The Third Class Trailer Car

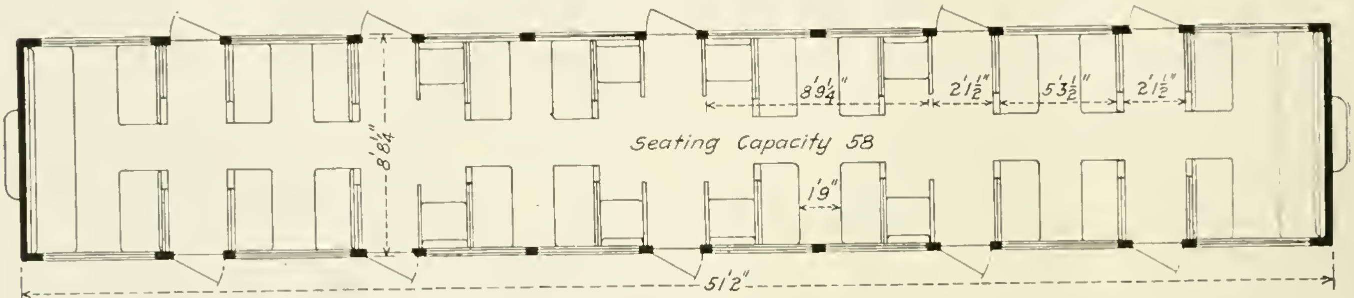
entirely unobstructed, while attention has also been paid to the improvement of lighting and heating and the provision of ventilation without draughts. A graceful dome roof has been provided, and a softening of the lights is obtained by the use of frosted bulbs and opal reflectors. A new system of switches enables the guard to control the lighting and eliminate delays due to independent car light switching.

A great point achieved in the new train is the elimination of strap-hanging, "steadying" rails being arranged to provide a hold for passengers, so that, while some standing will still be inevitable during the rush hours, the passengers, especially those of short stature, will be in a normal position.

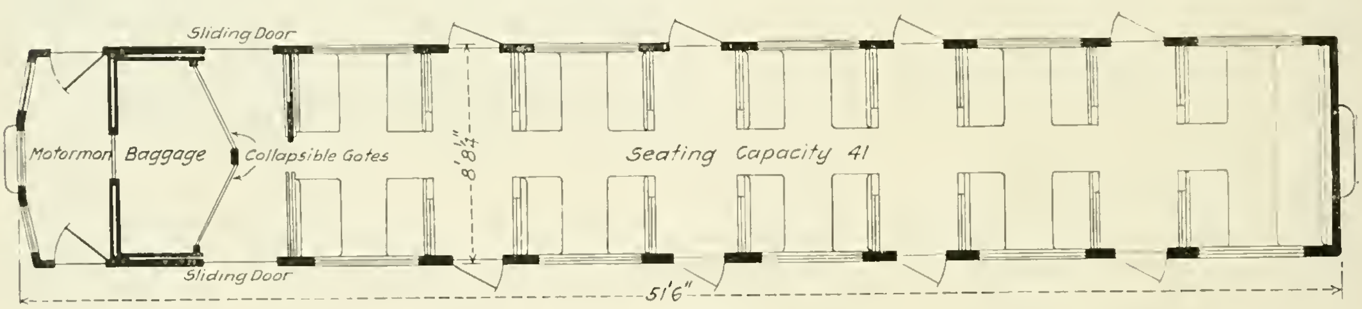
The side doors adopted are of the Metropolitan Company's standard type as fitted to compartment cars, but by means of



Floor Plan of First Class Driving Trailer Car



Floor Plan of Third Class Trailer Car.



Floor Plan of Motor Car

First Class Driving Trailer Car

spring buffers and strengthening of the longitudinal framing, door controlling straps have been eliminated, as also have window straps on the third-class coaches. A new form of lock has been fitted, which, while being very easily operated, is provided with a special catch, thus providing an additional safeguard.

To add to the facilities for quick entraining and detraining on the motor-cars, arrangements have been made to allow passengers to use the luggage compartment doors. The actual luggage compartments are enclosed by Bostwick sliding lattice gates, which will also prevent the pilfering of small articles, everything being within open view.

Although the end door has been dispensed with, special handles have been provided to enable guards to pass from one car to another in cases of emergency, while stepirons have also been provided for safely alighting on the track.

Various improvements have also been made for the safety and convenience of the traveling public by the provision of an improved device for controlling the "trip" for actuating

Non-Smoking Compartment of First Class Driving Trailer Car

the brakes in emergency, and automatic window wipers to enable the driver always to maintain a clear view. The improved buffing and draw gear should give smoother starting and stopping of the train. Route number indicators of an improved type have also been embodied.

While everything has been done to promote the comfort of the passenger, that of the train crew has not been overlooked, and comfortable seats have been provided for their use.

This new type of train is materially reducing the length of time required for entraining and detraining passengers, and thus increases the carrying capacity of the entire line.

Comity Between Competitors.—Erie Railroad commuters told a story of an obliging engineer who stopped their train to give away hot water. At Heller Field, the eastern landing field of the aerial mail service on the West Orange (New Jersey) branch, Pilot P. W. Smith was ready to start with the Chicago mail when it was discovered that the water pipes at the field were frozen and there was not enough hot water on hand to start his motor. As the train came in sight, someone flagged the train, and told the engineer of the pilot's trouble. "Glad to help you out," said the engineer. Two fifty-gallon tanks were rolled up the railroad embankment and the obliging engineer filled both with hot water.—*New York Times.*

FREIGHT CAR PAINTING*

BY W. A. BUCHANAN.

The painting of freight cars has become more essential at the present time than ever before since the building of this class of railway equipment. This is especially due to the fact that steel is fast replacing wood in their construction. Therefore, greater care must be exercised in their up-keep for the life of steel is rather brief if not watched and kept painted.

When cars are new, or re-built, it is essential, especially on steel cars, to thoroughly clean and paint all laps. Red lead has been found to be the best material for this purpose. The preparation of steel plates is very important and if permissible, sandblasting should be done before the application of paint, for the surface thus built up has proven the most satisfactory method for preventing corrosion, and paint adheres to the surface much better.

Freight car bodies of wood construction should be painted underneath all corner irons, or plates, before these parts are applied to cars. The roof boards should at least receive one good coat of paint before the running boards are applied. As soon as possible after the carpenters finish their work, the car should be primed. A mixture of some good metallic paint ground in oil, thinned to working consistency, has been found excellent material for this purpose. New work should receive at least three coats of paint if possible.

When roofs are of steel construction, special care should be exercised in painting them with some good steel car paint. When galvanized iron is used, the surface should be primed with galvanized iron primer for ordinary steel primers will not adhere to galvanized iron very long after being painted. This is very essential and should be carefully checked.

The standardization of freight car stencilling is one of the greatest problems confronting the master painter today, and for that reason the Master Painters' Association for years has been trying to show the necessity for adopting some general standard of letter and numeral for this class of equipment. No one item enters more into the expense of painting freight cars than does the making and upkeep of stencils. It necessitates the employment of a high rated employee in the first place to make the stencils and keep them in repair, and when we stop to consider the fact that most repair yards are obliged to give nearly as much attention to the repairs of foreign equipment as to system cars, some adequate idea may be had of the amount of time and material necessary to maintain stencils which of necessity must be kept in stock in order to replace standards of the various railroads. I might say in passing that no two roads have the same standard, either in style or shape of letters or numeral, although they are of Roman or Grecian style. This it will readily be observed necessitates an enormous outlay that could be eliminated is a standard could be agreed upon.

Next in order, I would recommend a standard grouping of the stencilling as follows: The initials or name of the road, together with the numbers of the car, should be placed to the left of the door. The lower markings should include the capacity of the car, cubical measurements, class, date built, weight, safety appliance markings, or any other marking of the above character. We then have grouped all of the information car inspectors or car checkers require to handle their work with dispatch. To the right of the door can be placed information showing the class of commodities the car was designed to carry. The lower marking should also show the length, height and width of the car. On the end of the car the initials of the road and the number of the car should be shown, placed at the right-hand corner of the car.

*From a paper presented before the Niagara Frontier Carmen's Association.

The lower markings should show the kind of triple valves, coupler shanks, draft rigging and brake beams with which the car is equipped.

Next in importance is the adequate paint protection required to keep air brake equipment in proper shape in order to insure against rust deterioration. Proper stencilling should be maintained at all times showing the dates when triples and cylinders were last cleaned.

A uniform standard of stencilling trucks is very important and should show the initials of the road and the number of the car to which the trucks belong. This information is very essential when cleaning up wrecks in order to enable men to sort out the right trucks, as the car body in many cases is completely destroyed, thus making it impossible to identify the car unless truck markings are available.

Proper facilities for handling the work is a most essential feature. This should include special trackage equipped with air lines and a maximum pressure of from 80 to 90 lbs. in order to air dust and spray the lower portions of cars and trucks. These tracks could be covered which would insure the conditions necessary to protect the men and the work after being painted and would also permit the painting operation during the winter months when traffic is lightest and freight car equipment can be spared to the best advantage.

USE OF THE ORIGINAL RECORD OF REPAIRS

In order to provide a uniform blank for reporting repairs made to foreign cars which would embody the necessary information for the preparation of billing repair cards and serve as a permanent record for the files of the company making repairs, a form, designated as the "Original Record of Repairs," which is shown on page 158 of the 1919 code of rules has been adopted. The importance of a uniform record of this kind has been generally recognized for some time, and if properly used it will simplify repair card writing to a great extent. Heretofore clerks writing up repair cards have been obliged to supply a great deal of information especially under the heading "Why Made," which has resulted in numerous cases of disputed car repair bills and unnecessary correspondence which could have been avoided had car

PEDESTAL ☐ **WHEEL AND AXLE STATEMENT** X ARCH BAR

WHEELS AND AXLES REMOVED						WHEELS AND AXLES APPLIED					
MAKER	RY. CO'S INITIALS ON WHEEL	WHEEL NO. DATE CAST	SERVICE METAL BEFORE TURNING	SERVICE METAL AFTER TURNING	CAUSE OF REMOVAL	MAKER	RY. CO'S INITIALS ON WHEEL	WHEEL NO. DATE CAST	SERVICE METAL	NEW OR SEC. HAND	NET CHARGE
G.W. Co.	None	5-16-07 847,812			Chipped rim	H. & B.	S.R.R.	9-26-19 241,906		New	S.H.
G.W. Co.	None	5-16-07 847,652			O.K.	H. & B.	S.R.R.	10-8-19 241,942		New	Axle

AXLE-LENGTH 7.2½ JOUR. 5×9 W.S. 6½ A.C. — LENGTH 7.2½ JOUR. 5×9 W.S. 6½ A.C. 5½

LOCATION R3-L3 SIZE & KIND OF WHEEL 33" Cast SIZE OF JOURNAL 5×9 M.C.B. OR NON M.C.B. M.C.B. — SIZE & KIND OF WHEEL 33" Cast SIZE OF JOURNAL 5×9 M.C.B. OR NON M.C.B. M.C.B.

WHEELS AND AXLES REMOVED						WHEELS AND AXLES APPLIED					
MAKER	RY. CO'S INITIALS ON WHEEL	WHEEL NO. DATE CAST	SERVICE METAL BEFORE TURNING	SERVICE METAL AFTER TURNING	CAUSE OF REMOVAL	MAKER	RY. CO'S INITIALS ON WHEEL	WHEEL NO. DATE CAST	SERVICE METAL	NEW OR SEC. HAND	NET CHARGE
National	N.Y.C.	2-10-13 4,765			Shelled out	H. & B.	S.R.R.	9-26-19 241,877		New	S.H.
Standard	P.R.R.	4-22-13 8,082			O.K.	H. & B.	S.R.R.	9-24-19 241,232		New	Axle

AXLE-LENGTH 7.2½ JOUR. 5×9 W.S. 6½ A.C. 5½ — LENGTH 7.2½ JOUR. 5×9 W.S. 6½ A.C. 5½

LOCATION R4-L4 SIZE & KIND OF WHEEL 33" Cast SIZE OF JOURNAL 5×9 M.C.B. OR NON M.C.B. M.C.B — SIZE & KIND OF WHEEL 33" cast SIZE OF JOURNAL 5×9 M.C.B. OR NON M.C.B. M.C.B.

DEFECT CARD AND JOINT EVIDENCE CARD RECORD

Grand Falls R.R. defect card (7-15-19), 1-5×5. Coupler in place of 5×7 "B" end. Card issued by Charles Day, Inspector at Glenn City. Wrong repairs not corrected.

REMARKS

Several boxes merchandise shifted and broken open. Contents checked by Agent C. A. Jones. Car "Bad Ordered" 11/1/19, by A. Fry, Train 90

SEAL RECORD	RECORD OF MATERIAL ORDERED
SEAL REMOVED E 87,604	DESCRIPTION
SEAL REMOVED	
SEAL APPLIED N.&S.Ry. 67,206	DATE ORDERED
SEAL APPLIED	DATE RECEIVED
CORRECT John Brown FOREMAN	CORRECT Henry Smith INSPECTOR

Reverse Side of the Form Used for Light Repairs

been properly checked at the time repairs were made. Erroneous prices, weights, etc., have also caused additional correspondence which would have been eliminated had a proper description of the material applied been given.

The most important feature, however, in the use of this form is the inspection of car before repairing is begun, which should not only provide an accurate record of the actual condition of all parts renewed, but should also result in great saving of ma-

terial as none but defective parts reported would be removed. The forms must be complete and accurate and must be signed by the person inspecting the car before repairs are begun and also by the person completing the report to vouch for the correctness of the items. Any corrections must be made by the person or persons signing the record. Billing repair cards must agree with the Original Record of Repairs in regards to details as far as is practicable.

The forms shown below are samples of the Original Record of Repairs used by one railroad for heavy and light repairs. The form for heavy repairs is 8½ in. by 14 in. and the reverse side provides space for recording as many as four pairs of wheels, while the form used for light repairs and cars on the loaded repair tracks is 8½ in. by 7 in. and provides a space for recording renewal of two pairs of wheels only. Each form provides space for Joint Evidence, Defect Card record, also seal records and record of material ordered from owners. Under the heading "Remarks" any information as regards the condition of the lading, etc., which might prove beneficial is also reported. Such records prove valuable assets if correct and complete but an incomplete record is worthless and time consumed in preparing it represents a total loss.

UNITED STATES RAILROAD ADMINISTRATION
DIRECTOR GENERAL OF RAILROADS
S. A. H. RAILROAD
ORIGINAL RECORD OF REPAIRS

Card No. 1
In 9-1 1919
Out 9-4 1919
Loaded or Empty Empty

Car No. 16456 Initial C.M.&S.Ry. Kind Box Cap'y 60,000 Length 36 ft.

End	No. Pcs.	Mat'l N	Mat'l SH	Repairs Made	Size	Wt.	Why Made
B	2	N		Center Sill Splice (respliced)	5x9x10 ft.		Broken
	1	N		Side Sill Splice (respliced)	4½x9x9 ft.		Broken
	1	N		Inter. Sill Slab	2x9x6 ft.		Broken
	1	N		End Sill (inside of sheath)	5½x9x9 ft.		Broken
	2	N		Long wooden draft timbers	5x8½x7 ft.		Broken
	25	N		End sheathing boards	⅞x3¼x9 ft.		Broken, out by load
	1	N		End facia board	⅞x12x9 ft.		Broken, out by load
	1	N		Crossover pipe nipple	1x7 in.		Broken a/c seam
	1	N		Check case union	1 in.		Broken a/c seam
	1	N		Retainer pipe nipple	⅜x8 in.		Broken, insecure, fasten

Portion of a Typical Repair Record

CAR BUILDING IN RUSSIA

Commerce Reports in a recent issue publishes an interesting letter from John P. Hurley, consul at Riga, relative to ship and car building facilities at Reval. The letter is dated January 26. Those portions of it relating to car building are given in part as follows:

The position of the Dwigatel car shops is especially favorable for supplying cars to the railroads of Russia. None of the machinery of this plant was evacuated on the approach of the Germans, owing to protests of the workmen; hence the plant is complete. Judging by the condition of rolling stock in Latvia and Esthonia, the condition of rolling stock throughout Russian must be very poor. Prior to the war there were about 600,000 freight cars in Russia, whose railway system covered about 45,000 miles. The car census per mile of track would be 13 of about 14 short tons capacity each.

There were in old Russia, in 1917, 11 car factories, as follows: In Reval, 1; Petrograd, 2; Tver, 1; Moscow, 1; Rybinsk, 1; Kolomna, 1; Bornovo, 1; Briansk, 1; Nicolaev, 1, and Ust-Katavsk, 1. Kerensky placed among these works orders for 200,000 cars of 20 tons each, shipment to begin in 1920 and extend over five years. The position of the Reval shops would afford an early start in car building not enjoyed by any other shops. The works are running at about 25 per cent capacity repairing locomotives and cars for the Esthonian Government. The plant is intersected throughout with railways and similarly connected with the town. Erecting shops in good condition would permit work on about 200 cars simultaneously. A supply of wheels and axles, sufficient for immediate needs, is on hand, but the factory is in urgent need of tires and spring steel. The power plant is complete and of about 1,500 horsepower. The machine shop is a two-story building of limestone (as are all other buildings) about 90 feet by 250 feet, and completely equipped with requisite machinery. The forge shops are about 300 feet square and equipped with about five 3-ton drop hammers. As with every factory in this country, the greatest need is coal, coke and lubricating oil.

Wages in Reval run from 30 to 60 Esthonian marks a day, but owing to the recent disturbance will undoubtedly increase. Here, as in every other country, labor has demanded increased wages and shorter working hours. At present 18 to 30 marks a day is paid for unskilled labor, and 40 to 60 marks a day for skilled labor. The rate of exchange is 100 marks to the dollar for currency, and 90 to the dollar for checks. The base value of the mark is 25 to the dollar.

The director of the car-building plant states that practically all of his skilled workmen still remain, and that the shops have worked continuously. Both the shipbuilding yards and the Dwigatel car building works deserve attention, and it is extremely probable that capital of other countries is interested. The belief obtains here that in the United States alone can requisite capital be obtained, and American prestige among business interests is very high.

The Inspection of Freight Equipment*

Safety Appliance Standards and Federal Inspection; Doors, Roofs and Air Brakes

BY L. K. SILLCOX

Master Car Builder, Chicago, Milwaukee and St. Paul

One hand hold over each ladder is to be provided. They must be 5/8 in. in diameter of wrought iron or steel. The tread must be not less than 16 in. with a minimum clearance of 2 in. They shall be securely fastened by not less than 1/2-in. bolts with the nut outside (if possible) riveted over, or with 1/2-in. rivets, located one parallel to the tread of each ladder not less than 8 in. nor more than 15 in. from the edge of the roof.

There are exceptions on refrigerator cars when ice hatches prevent; on such cars the location may be nearer the edge of roof. Other exceptions are on caboose cars; where stiles of ladders extend 12 in. or more above the roof, no other roof hand holds are required.

Another type of roof hand hold used is one right angle hand hold which may take the place of two adjacent specified roof hand holds, provided the dimensions and locations coincide (M. C. B. rules require them to be without weld). The special requirements for these right angle hand holds provide that they must have an extra leg, securely fastened to the car at the point of the angle. This is a necessary safety precaution.

Cupola Handholds

Cupola hand holds to be provided are one or more, located as follows: one continuous hand hold extending around the top of the cupola, not more than 3 in. from the edge of the cupola roof, or four right angle hand holds, one at each corner not less than 16 in. in clear length from the point of the angle, which may take the place of the one continuous hand hold specified, if the locations coincide.

Running Boards

Running boards must be made of wood, running the full length of the car in the center of the roof, and securely fastened, the exception being that on caboose cars with cupola, longitudinal running boards shall extend from the cupola to the ends of the roof. Other conditions specified are that the length and width of running boards may be made up of a number of pieces securely fastened to saddle blocks, with bolts or screws, but the running boards must not be cut or hinged at any one point.

Additional requirements for cars with outside metal roofs provide that two latitudinal extensions shall be used from the longitudinal running boards to the ladder location. The proper width of these boards is as follows: the longitudinal running boards shall be not less than 18 in. in width, and the latitudinal extensions not less than 24 in. in width. The following cars are excepted: tank cars without side sills, tank cars with short side sills and end platforms and tank cars without end sills. The proper width of running boards on the above named cars is: minimum width 10 in. on the side and 6 in. on end.

Cars not requiring latitudinal extension are: refrigerator cars, on account of ice hatches.

Longitudinal running board and clearances are specified as follows: the ends shall be not less than 6 in. nor more than 10 in. from a vertical plane parallel with the end of the car, exceptions being: tank cars without side sills, tank cars with short side sills and end platforms and tank cars without end sills. The end clearance specified for these cars is not less than 6 in., the measurement to be taken from a line passing through the inside face of the knuckle, when closed with the coupler horn against the buffer block, the end sill or the back stop.

If running boards extend more than 4 in. from the edge of the roof, they must be supported for the full width by substantial metal braces.

The following classes of tank cars must be equipped with running boards: tank cars without side sills, tank cars with short side sills and end platforms and tank cars without end sills. One continuous running board is required around the sides and ends or two boards running the full length of the tank, one on each side. Tank cars having end platforms extending to the bolsters are to be equipped with running boards extending from center to center of bolsters, one on each side.

Side running boards that are applied below the center of the tank are to be put up as follows: the outside edge of such running boards shall extend not less than 7 in. beyond the bulge of the tank, these running boards to be securely fastened to the tank or tank bands.

Safety Railings

Tank cars are to be provided with one safety railing continuous around the sides and ends of the tank, or two running the full length of the tank. The proper diameter, kind of material and clearance are, on tank cars with side platforms, not less than 3/4 in. iron; on tank cars without side sills and tank cars with short side sills and end platforms, tank cars without end sills, not less than 7/8 in. wrought iron or steel with a clearance of 2 1/2 in.

The safety railings must be placed not less than 30 in. nor more than 60 in. above the running board or platform. They must be securely fastened to the tank, tank bands or posts, and secured against end shifting.

End Ladder Clearances

The end ladder clearance requirements are that no part of the car above the end sills, within 30 in. from the side of the car (except buffer block, brake shaft, brake step, brake wheel, running boards or uncoupling lever and air hose which are not to be regarded as fixtures as the word is used in the part of the order relating to end ladder clearance) shall extend to within 12 in. of a vertical plane parallel with the end of the car and passing through the inside face of the knuckle when closed, with the coupler horn against the buffer block or end sill.

Other conditions are that no other part of the end of the car or fixtures thereon above end sills, other than the exceptions named above, shall extend beyond the outer face of the buffer block.

High side gondolas and high side hopper cars are those with sides which extend more than 36 in. above the floor. Low side hopper or gondola cars are those which extend 36 in. or less above the floor.

Cars which may be equipped the same as flat cars are those with sides which extend 12 in. or less above the car floor.

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*Fourth of a series of articles on this subject by Mr. Sillcox.

Classification of Defects To Be Reported by Federal Inspectors

The following is a list of the defects of safety appliances required to be reported by the inspectors of the Bureau of Safety.

COUPLERS AND PARTS

1. Coupler body broken.
2. Coupler body missing.
3. Coupler worn (See footnote A.).
4. Knuckle broken.
5. Knuckle missing.
6. Knuckle worn (See footnote A.).
7. Knuckle pin bent.
8. Knuckle pin broken.
9. Knuckle pin missing.
10. Knuckle pin wrong (See footnote B.).
11. Lock block bent (See footnote B.).
12. Lock block broken.
13. Lock block missing.
14. Lock block inoperative (State particulars).
15. Lock block wrong (See footnote B).
16. Lock block worn (See footnote A.).
17. Lock block key missing.
18. Lock block trigger missing.
19. Lock set missing.
20. Guard arm short.

Note A—Nos 3. 6 and 16 are defects only when worn sufficiently to destroy contour line by allowing lost motion to approach the danger point as shown by A. R. A. limit gage.

Note B—Nos. 10, 11 and 15 are defects only when interfering with safe operation.

In reporting defects to couplers state names thereof.

UNCOUPLING MECHANISM.

24. Lock link bent (See footnotes A and C.).
25. Lock link broken (See footnote C.).
26. Lock link missing (See footnote C.).
27. Uncoupling lever bent (See footnote A.).
28. Uncoupling lever broken.
29. Uncoupling lever missing.
30. Uncoupling lever incorrectly applied (State particulars.).
31. Uncoupling lever wrong (See footnote B.).
32. Uncoupling chain broken.
33. Uncoupling chain missing.
34. Uncoupling chain kinked (See footnote C.).
35. Uncoupling chain too short.
36. Uncoupling chain too long.
37. End lock, or casting, bent.
38. End lock, or casting, broken.
39. End lock, or casting, loose (See footnote A.).
40. End Lock, or casting, missing.
41. End lock, or casting, incorrectly applied.
42. End lock, or casting, wrong (See footnote A.).
43. Keeper bent.
44. Keeper broken.
45. Keeper loose (See footnote A.).
46. Keeper missing.
47. Keeper incorrectly applied.
48. Keeper wrong (See footnote A.).
49. Uncoupling lever stop broken (See footnote D.).
50. Uncoupling lever stop loose (See footnote D.).
51. Uncoupling lever stop missing (See footnote D.).
52. Uncoupling lever stop incorrectly applied (See footnote D.).

Note A—Nos. 24, 27, 39, 42, 45 and 48 are defects when interfering with the proper operation of uncoupling mechanism.

Note B—No. 31, under this head include all uncoupling levers which are too long or too short. State particulars.

Note C—Give name of coupler when reporting defects Nos. 24, 25 26 and 34.

Note D—Defects Nos. 49, 50, 51 and 52 apply to levers of the "rocking" or "pushdown" type.

State names of any patented uncoupling levers found defective.

When a clevis or clevis pin is missing so that the uncoupling chain is disconnected, report the defect as 32, which is ample detail for purpose of general inspector.

Compound defects, viz., where one defect causes another, as, uncoupling lever bent making chain too long, may be reported thus: (27-36).

VISIBLE PARTS OF AIR BRAKES.

55. Air brake cut out.
56. Cylinder and triple not cleaned within 12 months (Give date of last cleaning.).
57. Cylinder and triple last cleaned, no date.
58. Air hose missing.
60. Air hose gasket missing.
61. Air hose gasket defective.
62. Air hose coupling defective (State particulars.).
63. Angle cock missing.
64. Angle cock defective.
65. Angle cock handle broken.
66. Angle cock handle missing.
67. Train pipe broken.
68. Train pipe loose.
69. Train pipe bracket missing.
70. Cross-over pipe defective (State particulars.).
71. Cut-out cock defective (State particulars.).
72. Cut-out cock handle broken.
73. Cut-out cock handle missing.
74. Cylinder casting defective.
75. Cylinder loose.
76. Reservoir casting defective.
77. Reservoir loose.
78. Triple valve casting defective.
79. Triple valve missing.
80. Release cock defective.
81. Release cock missing.
82. Release rod broken.
83. Release rod disconnected.
84. Release rod missing.
85. Piston travel excessive (State particulars.).
86. Retaining pipe defective (State particulars.).
87. Retaining pipe missing.
88. Retaining valve defective (State particulars.).
89. Retaining valve missing.

HANDHOLDS

90. Handhold bent.
91. Handhold broken.
92. Handhold loose.
93. Handhold missing.
94. Handhold incorrectly applied (State particulars.).
94. Handhold too short (State particulars.).
96. Handhold not having proper clearance (State particulars.).

In reporting defects to handholds, state in remarks location of same.

100. Coupler too high (State height.).
101. Coupler too low (State height.).
102. Carrier iron loose.

Inspectors must exercise judgment in determining defects of this class. See that the car is standing on an approximately level track before measurements are taken.

STEPS

105. Sill step bent.
106. Sill step broken.
107. Sill step loose.
108. Sill step missing.
109. Sill step incorrectly applied (State particulars.).
110. Sill step wrong dimensions (State particulars.).
111. Caboose platform step broken.
112. Caboose platform step missing.
114. Caboose platform step incorrectly applied (State particulars.).
115. Caboose platform, step wrong dimensions (State particulars.).
116. Side door step bent.
11.7 Side door step broken.
118. Side door step loose.
119. Side door step missing.
120. Side door step incorrectly applied (State particulars.).
121. Side door step wrong dimensions (State particulars.).

LADDERS

125. Ladder tread bent.
126. Ladder tread broken.
127. Ladder tread loose.
128. Ladder tread missing.
129. Ladder tread not having proper clearance (State particulars.).
130. Ladder treads improperly spaced (State particulars).
131. Ladder loose.
132. Ladder incorrectly applied (State particulars.).
133. End ladder clearance inadequate (State particulars.).

In reporting defects to ladders, state whether end or side.

RUNNING BOARDS

135. Running board broken.
136. Running board loose.
137. Running board missing.
138. Running board wrong dimensions (State particulars.).
139. Running board not properly secured to car (State particulars.).
140. Running board brace broken.
141. Running board brace loose.
142. Running board brace missing.
143. Running board cleat broken.
144. Running board cleat loose.
145. Running board cleat missing.
146. Latitudinal extension broken.
147. Latitudinal extension loose.
148. Latitudinal extension missing.
149. Latitudinal extension wrong dimensions (State particulars.).
150. Latitudinal extension not properly secured to car (State particulars.).

HAND BRAKES

151. Brake shaft bent.
152. Brake shaft broken.
153. Brake shaft loose.
154. Brake shaft incorrectly applied (State particulars.).
156. Brake shaft top nut missing.
157. Brake shaft cotter key or ring at bottom of shaft missing.
158. Brake shaft wrong dimensions (State particulars.).
159. Brake shaft with weld.
160. Brake wheel broken.
161. Brake wheel loose.
162. Brake wheel missing.
163. Brake wheel incorrectly applied (State particulars.).
164. Brake wheel wrong dimensions (State particulars.).
165. Ratchet wheel broken.
166. Ratchet wheel loose.
167. Ratchet wheel missing.
168. Ratchet wheel incorrectly applied (State particulars.).

169. Ratchet wheel wrong dimensions (State particulars).
170. Ratchet wheel, insufficient teeth (State particulars.).
171. Brake pawl broken.
172. Brake pawl loose.
173. Brake pawl missing.
174. Brake pawl incorrectly applied (State particulars).
175. Brake step broken.
176. Brake step loose.
177. Brake step missing.
178. Brake step incorrectly applied (State particulars).
179. Brake step, wrong dimensions (State particulars.).
180. Brake step brace broken.
181. Brake step brace loose.
182. Brake step brace missing.
183. Brake step brace incorrectly applied (State particulars.).
184. Brake shaft stirrup bent.
185. Brake shaft stirrup broken.
186. Brake shaft stirrup loose.
187. Brake shaft stirrup missing.
188. Brake shaft stirrup wrong (State particulars).
189. Top brake shaft support broken.
190. Top brake shaft support loose.
191. Top brake shaft support missing.
192. Top brake shaft support incorrectly applied (State particulars.).
193. Top brake shaft bracket bent.
194. Top brake shaft bracket broken.
195. Top brake shaft bracket loose.
196. Top brake shaft bracket missing.
197. Brake chain broken.
198. Brake chain missing.
199. Brake chain wrong dimensions (State particulars).
200. Brake chain too long.
201. Brake chain not properly fastened to brake shaft drum (State particulars.).
202. Hand brake rod broken.
203. Hand brake rod missing.
204. Hand brake rod too long.
205. Hand brake rod disconnected.
206. Hand brake.
206. Floating lever broken.
207. Floating lever disconnected.
208. Floating lever missing.
209. Floating lever guide broken.
210. Floating lever guide loose.
211. Floating lever guide missing.
212. Floating lever fulcrum broken.
213. Floating lever fulcrum loose.
214. Floating lever fulcrum missing.
215. Floating top truck rod broken.
216. Top truck rod disconnected.
217. Top truck rod missing.
218. Bottom truck rod broken.
219. Bottom truck rod disconnected.
220. Bottom truck rod missing.
221. Truck live lever broken.
222. Truck live lever disconnected.
223. Truck live lever missing.
224. Truck dead lever broken.
225. Truck dead lever disconnected.
226. Truck dead lever missing.
227. Truck dead lever fulcrum broken.
228. Truck dead lever fulcrum disconnected.
229. Truck dead lever fulcrum missing.
230. Cylinder lever broken.
231. Cylinder lever disconnected.
232. Cylinder lever missing.
233. Cylinder lever guide broken.
234. Cylinder lever guide loose.
235. Cylinder lever guide missing.
236. Brake beam bent.
237. Brake beam broken.
238. Brake beam missing.
239. Brake beam fulcrum broken.
240. Brake beam fulcrum loose.
241. Brake beam fulcrum missing.
242. Brake head broken.
243. Brake head loose.
244. Brake head missing.
245. Brake shoe broken.
246. Brake shoe missing.
247. Brake shoe key broken.
248. Brake shoe key missing.
249. Brake hanger broken.
250. Brake hanger loose.
251. Brake hanger missing.
252. Brake hanger hook or casting broken.
253. Brake hanger hook or casting loose.
254. Brake hanger hook or casting missing.
255. Cylinder rod broken.
256. Cylinder rod disconnected.
257. Cylinder rod missing.

Any defects or combination of defects which render the hand brakes inoperative shall constitute a violation.

Equipping Foreign Cars with Safety Appliances

Close attention is essential in the matter of giving proper attention in the equipping of cars with safety appliances, both foreign and system cars. Whenever system cars are loaded and it is found they are not equipped with safety appliances, if routed to some foreign railroad, the routing and destination should be ascertained in order to take the matter up with the foreign railroad to have them equip cars belonging to this road. It is necessary also to equip foreign cars on our railroad, rendering bills against the owners for the expense we are put to. System cars, not equipped, must also be followed to destination points on the railroad and and equipped when empty. Cars stencilled as equipped and found actually not so provided, if loaded, are to have the stencilling painted over, if empty, the cars shall be equipped at the owner's expense.

Side and End Doors and Side Door Protection

Doors should be carefully inspected to see that the bottom door guides are in place and tight to prevent pilfering from the car. Door locks and hasps should be in proper condition and in place so that the doors can be properly fastened and sealed. Doors, either top or bottom hung, should be in proper condition and properly secured in place and arranged to close tightly to prevent admission of elements or sparks that would damage freight. Doors on gondola and hopper cars need careful inspection to see that they are in operative condition and close tightly and that the operating mechanism will permit the doors to be closed and locked in such a way that they will not open, to prevent loss of lading.

One of the greatest difficulties with side doors is the prevailing lack of attention to the application of suitable protection in the doorway. It is not reasonable to suppose that cars loaded with bulk vegetables such as potatoes, or shipments in sacks such as flour, sugar, peas, beans, coffee, etc., or paper in large rolls, piled vertically or longitudinally, or commodities in barrels, cases or otherwise, will make a successful run without damage and loss, unless some consideration is given the consistency of trying to hold the lading, which is so apt to shift on account of train and yard movement inside of the car, with the single layer of boards composing the door itself, when a massive side construction in the car body is necessitated for this same purpose. Doors which become bulged bind and interfere with line clearances causing tremendous damage aside from dislocating the doors themselves, ruining adjacent equipment and exposing shipments subject to loss. In this way doors become inoperative and as a result shippers tear them loose with claw bars. Much can be done by interesting shippers in this direction, and if properly handled and the case is made plain to them, their co-operation is obtained.

At interchange points the strictest watch is necessary. Redress must be insisted on from connecting lines for any failure on their part in this regard. This does not mean that it is desired to have the whole opening closed up inside of the doorway. In the case of paper stock in rolls standing vertically, a 1½-in. by 8-in. strip across the doorway, about three quarters of the way up the roll, will keep the lading from doing any damage to the door and the same is true of barrels. Doors should never be spiked to the car frame and care is required to see that shippers refrain from this practice, using suitable wooden slats if the door needs fastening. On loaded cars, inspectors should always be certain that door caps, and stop and spark strips are in good order to avoid the elements entering the car causing damage, and should also see that door guides, track, hasps, rollers, hinge pins and fasteners are all secure and in place. In the case of refrigerator cars, they should see that the side doors fit tightly in place to avoid perishables becoming destroyed, also special care is necessary in the case of loaded cars of stock.

Threshold Plates

On system cars the use of threshold plates is not desired, therefore, cars receiving Class A, B and C repairs are to have them removed and reclaimed for useful purposes.

Roofs for Freight Cars

Roofs of all cars on repair tracks must be inspected and if metal roofs or double board plastic roofs have outside

boards loose, the loose nails must be drawn and the boards renailed with two nails staggered in each board at each purlin, side plate and ridge pole. In renailing care must be taken to use proper sized nails, so that metal roofing will not be punctured, the correct size being 2¼ in. No. 8 barbed wire. All nail holes left open after renailing are to be carefully and properly filled with "Sarco," "Bako" or other suitable material to prevent leakage.

Where bolts are employed to hold the roof structure or roofing in place, all bolts are to be tightened up through the ridge pole, carlines, running board brackets, etc., and have nut locks or lock nuts applied to prevent the structure from again becoming loose. Where suitable means are not available for holding the nuts in place, either through lack of material or because of the nature of the repairs, the threads of the bolt should be cut with chisel to prevent the nuts coming off.

When metal roofs are damaged in wrecks care must be taken to save all metal parts that can be used from cars destroyed. When cars are not destroyed, all parts must be placed in the car to which they belong. When cars damaged in wrecks are to be burned, serviceable metal roofs or parts must first be removed. When condemned cars are to be burned or torn down, serviceable metal roofs or parts of same must be carefully removed and kept for further use.

Wooden running board saddles must be secured to the ridge pole by two 4½ in. No. 18 screws and at the ends by two 4½ in. No. 18 screws. Running boards, when loose, must be secured in place by 2½ in. No. 16 screws, two per board at each crossing.

In addition to the repair track inspection and running inspection, the inspection at terminals must include the roof, with handholds, brake shafts and attachments, brake step, etc., and at points where there are shops, and it can be so arranged, men should be regularly assigned to renail roofs and secure running boards and saddles and fasten roof handholds in freight car yards. All roof handholds must be tested by hand or with a bar when on repair tracks, and if not perfectly secured they must be refastened and secured by bolts through solid wood. One longitudinal running board is required and cars with outside metal or all metal roofs two latitudinal extensions. Longitudinal running boards shall be not less than 18, preferably 20 in. in width. Latitudinal extensions shall not be less than 24 in. in width. Running boards are to be located the full length of the car, at the center of the roof. On outside metal roof cars there shall be two latitudinal extensions from the longitudinal running board to the ladder location, except on refrigerator cars, where such latitudinal extensions cannot be applied on account of ice hatches.

Running boards are to be continuous from end to end and not cut out or hinged at any point; provided, that the length and width of running boards may be made up of a number of pieces securely fastened to saddle blocks with bolts or screws. The ends of longitudinal running boards shall be not less than six, nor more than ten inches from a vertical plane parallel with the end of the car and passing through the inside face of the knuckle when closed with the coupler horn against the buffer block or end sill, and if more than four inches from the edge of the roof of the car, shall be securely supported their full width by substantial metal braces. Running boards shall be made of wood and securely fastened to the car by bolts or screws.

Metal roofs when furnished in accordance with separate instructions, must be applied promptly and properly. Roofs of cars should be maintained in good condition to insure proper protection of contents and avoid damage claims.

Air Brakes

Air brakes should be examined, cleaned and tested in accordance with the rules governing same. Hand brakes should be operative and capable of holding cars in switching and on grades in addition to meeting the Safety Appliance Laws. Air and signal hose should be in good condition and not more than two years old in the principal trains, gaskets should be examined for tightness to avoid any possible leakage. All piping should be free from abrasions. All rods should be free, full size and prevented against knocking and causing wear or annoyance to passengers in service. All brake rigging parts should stand at least three inches clear above the top of the rail. All cotter pins should be in place and properly spread to prevent being lost. All pipe clamps are to be tight and the location of piping on the ends of cars is to be such as to avoid any buckling or cramping of air or signal hose when connected up.

Couplings for air and signal hose are to be in good order, piston travel to be normal, about seven inches, and all brakes to be operative unless a defect card is wired to the crossover piping, stating the trouble and where found such defects to be remedied before the train departs, if possible, without causing delay and wire advice to be sent forward to the first principal repair station to prepare to remedy the trouble in case the defect cannot be handled locally. Retaining valves must be known to be in proper position. If the train line on passenger cars is broken or defective special combination couplings may be used as found in all standard station boxes, so as to run the air supply through the signal line temporarily until repairs can be made. All passenger car brake cylinders and slack adjusters are to be cleaned every six months, dirt collectors, triple valves, retainers and high speed valves should be cleaned every three months. Inspectors will watch this closely and keep their foremen advised of any irregularity regarding this.

Before departure of all trains inspectors should satisfy themselves that the brakes have thoroughly released to avoid slid flat and burst wheels. Slack adjusters should be maintained in such a way as to provide about ⅜-in. initial shoe clearance on all wheels.

Specification Covering Installation of Air Brake Equipment on Freight Cars

Brake Cylinder and Auxiliary Reservoir.—The cylinder and reservoir must be attached substantially with metal supports having ample strength to avoid deflection during brake applications, with a cylinder pressure of 70 lb. They should be secured with bolts fitted with double nuts or approved lock washers and the bolt heads prevented from turning. Washers must be applied between the brake cylinder and auxiliary reservoir bolting flange and their supporting brackets where necessary to avoid strains in the cylinder or reservoir when the supporting bolts are tightened.

The brake cylinder should be so located as to permit easy removal and replacement of the brake piston. This requires sufficient clearance to permit the piston and non-pressure head to be moved outward horizontally 15 in. The lever guide for the cylinder end of the cylinder lever is to be so located as to provide ample room for removal and replacement of the brake piston.

Release Valve.—The release valve should be installed in the top of the auxiliary reservoir and arranged for operation with ⅜ in. rods to each side of the car.

Brake Piping.—The brake pipe must be 1¼ in., with standard weight pipe nipples not less than 10 in. long at each end. The M.C.B. standard is 10 in. Angle cocks must be located as per M.C.B. standard. Pipe near the angle cocks and elsewhere is to be secured by approved clamps that will prevent vibration or movement otherwise.

The branch pipe from the main brake pipe is to be reduced from 1¼ in. to 1 in., with a nipple not over 3 in. long at connection to the triple valve, and to contain two 90-degree pipe fittings so placed as to permit flexibility to compensate for reasonable variations in the location of the brake pipe

tee and triple valve. A substantially true bearing of the gasket face of the union on the triple valve must be insured, so that the connection may be made without producing undue strain on the union. If the branch pipe passes through the center sill, the sill must be slotted so that the branch pipe union can be moved sufficiently to permit of easy removal of the triple valve.

The cutout cock handle is to turn upward to close, and if practicable should be located so that it can be seen from either side of the car.

The centrifugal dirt collector is to be placed between the cutout cock and triple valve, so located that the drain plug can be readily removed. The raised arrow on the cock is to point toward the triple valve. The bottom of the drain plug must not be lower than the bottom of the triple valve.

Retaining Valve and Pipe.—The retainer and pipe must be located securely in a vertical position on the end of the car near the brake staff and with sufficient clearance for the removal of the cap. Where the pipe passes through the hand brake step, the step should be slotted sufficiently to permit of springing the pipe back enough to remove and replace the retaining valve. On cars having drop ends, the retaining valve is to be accessibly located on the side of the car near the brake staff end.

The retainer pipe is to be connected to the triple valve with a short section containing a 90-degree bend, each leg preferably six inches long, with the union on the end of this bent section. The outer end of the bent section is to point vertically upward, or approximately so, in order to provide the necessary flexibility. The pipe is to be clamped about six feet from both the triple valve and retaining valve and at intervals of about six feet between, the clamps to be substantial and solidly secured. One union only is to be used, unless it is impracticable to so install the valve.

Piping, General.—Pipe ends are to be reamed to full size after cutting, and pipes hammered and blown out before erecting. When it is absolutely necessary to install unions in the brake pipe they must be accessibly located for maintenance.

Pipe Fittings.—All piping is to be assembled with as few fittings as practicable, and all fittings used, with the exception of those regularly included in the air-brake schedule, are to be "extra quality pipe fittings for railroad air brake service," as listed in the Westinghouse Air Brake Company's Special Publication, No. 9021. Unions are to be brass-to-iron seat, taper joint type.

Braking Power.—The brake rigging is to be designed to produce braking power equal to 60 per cent of the empty car weight, based on 50-lb. cylinder pressure, excepting for cabooses, which will be braked at 45 per cent. The value of an eight-inch cylinder at 50-lb. pressure is 2,500 lb., and of a ten-inch cylinder 3,950 lb.

Note.—While the M.C.B. standard requires the use of the ten-inch equipment with cars exceeding 37,000 lb. empty weight, the more uniform piston travel maintained, with less expense and delay with lower total leverages, warrant the use of the ten-inch equipment on much lower empty weights.

Brake Beams.—Brake beams must have sufficient strength to carry a force equivalent to .21 times the empty weight of the car without deflecting more than .07 in. (the M.C.B. deflection limit). Brake beams are to be suspended at the M.C.B. standard height from the rail (13 in.). The suspension is to be from the rigid portion of the truck frame with brake beam hangers of the U-type, made of material not less than 7/8 in. in diameter and not less than 8½ in. long, center to center, preferably much longer.

The spacing of the brake heads is to be according to the M.C.B. standard, that is, 60 in. from center to center of brake heads, with a maximum allowable spacing of 60⅛ in. and a minimum of 59⅞ in.

The brake beam hanger is to be attached to the truck frame at a point that will prevent the hanger from assuming an angle to a line through the centers of the beam and journal, which will cause excessive toggle or wedging action under brake application when brake shoes and wheels are of minimum dimensions.

Strength or Brake Rigging.—All brake rigging is to be designed to carry the forces resulting from a brake cylinder pressure of 70 lb. without exceeding the M.C.B. stress limits, which are:

Levers	23,000 lb. per sq. in.
Rods	15,000 lb. per sq. in.
Jaws	16,000 lb. per sq. in.
Pins	10,000 lb. per sq. in.
Pin bearing (on projected area)	23,000 lb. per sq. in.

The value of an eight-inch cylinder at 70 lb. is 3,500 lb. and of a ten-inch cylinder 5,530 lb.

The hand-brake rigging is to be designed to meet these requirements, and with 1,500 lb. pull on the hand-brake rod, except where a geared hand brake is employed, in which case the forces to be carried will be increased in proportion to the hand brake gear ratio.

Levers, General.—All pin holes in brake levers must be on the longitudinal center line. Levers must not be bent or offset sidewise. Both the front and back cylinder levers are to be as long as practicable and so designed and located as to prevent a lateral thrust on the push rod when the brake is applied. Live and dead truck levers are to be in the same ratio with as low a proportion as practicable and in no case to exceed four to one, i. e., produce more than four pounds force on each brake beam for one pound exerted on the top of the live lever.

Slack Adjustment.—With cars having deep side sills a hole must be provided through which to observe the piston travel. Slack adjusting fulcrums and bottom rods must be provided with a sufficient number of holes properly located to permit of accurate piston travel adjustment for new shoes and wheels as well as for shoes and wheels of minimum dimensions and at the same time must permit of maintaining levers at substantially right angles to the rods under brake application with eight-inch piston travel.

All pins should be removed from pin holes in slack-adjusting fulcrums to permit free movement of levers. The hand slack adjuster is to be so attached to the trucks that there will be no toggle action when the dead levers are in their closest position to the truck bolster.

Rods.—Brake rods should be of such length as to produce, with an emergency application from 70 lb. brake pipe pressure, piston travel of six inches to seven inches, the truck levers being attached to the inside holes of the slack-adjusting fulcrums and bottom rods.

With the brake applied and eight inches piston travel, the top rods and cylinder rod should be of such length that the cylinder levers will stand at a right angle to the longitudinal center line of the car, and the length of the bottom rod should be such that the live truck lever will not pass beyond a right angle to the top and bottom rods. Sufficient clearance should be provided between the top rods and the axles to insure against rods being cut.

Lever Guides.—Sufficient clearance must be given to permit free movement of all levers to the positions they will assume when the brake shoes and wheels are of minimum or maximum dimensions and the piston is in release position or its travel is 12 in.

Brake Pins and Pin Holes.—These parts are to be strictly in accordance with M.C.B. standards.

Rail Clearance.—The brake rigging is to be so installed that with the maximum allowable tire turning, wear of journal bearings, etc., the brake rigging will clear the rails not less than 2½ in.

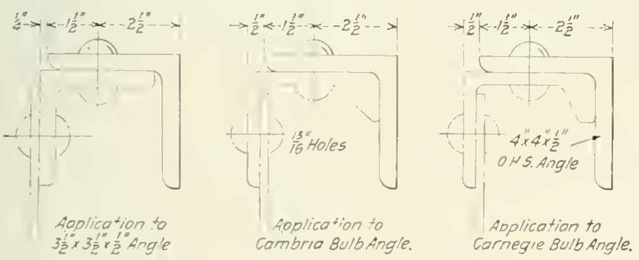
(*To be continued.*)

REINFORCING TOP CHORD ANGLES ON GONDOLA CARS

BY NORMAN McCLEOD.

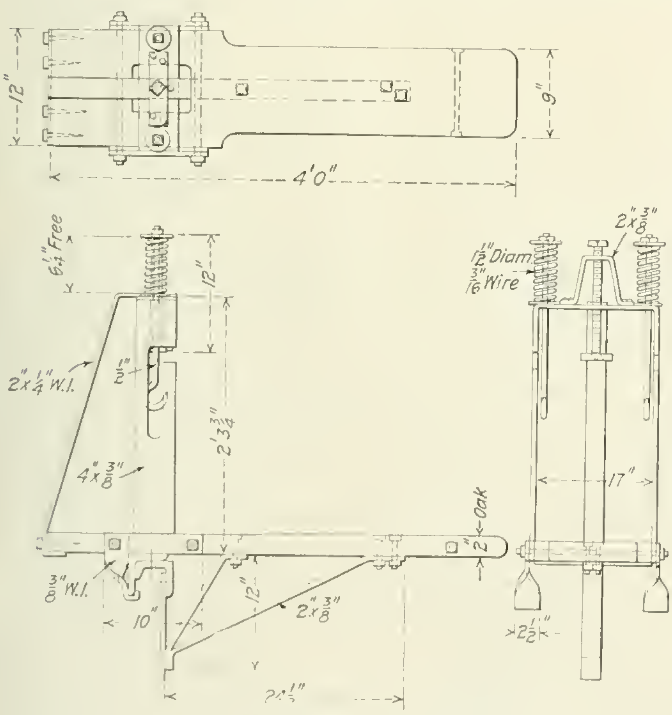
Owing to the bulging of the sides of steel freight equipment cars, especially those of the gondola type, it has been found necessary on certain cars to reinforce the top chord by applying a 4-in. by 4-in. by ½-in. steel angle, as shown in the cross sections in Fig. 1. These reinforcing angles are in one piece and are drilled and riveted at intervals of about eight inches. Ordinarily it required two men to do this work, but the device shown on the accompanying drawings makes it possible for one man to do it.

The device consists of an oak seat (on which the operator



Method of Reinforcing Typical Sections

sits), to which is bolted a wrought iron vertical member in the form of a yoke. From the yoke is suspended the air motor drill, the arms being supported by two hooked ½-in. rods. These arms are provided with two springs, which, as



General Arrangement of the Drill Support

the drilling progresses, are in tension. After the drill has passed through, these springs draw the drill out of the hole automatically as the feed screw is backed off, since the springs keep the drill feed screw center point always up against the lower end of the adjusting screw, on the end of which is a female center to receive it. Thus the springs prevent a sudden dropping of the heavy air drill, which might injure not only the machine but also the operator.

The hooks on the side of the seat engage the downward pointing leg of the angle being drilled and with the brace beneath the seat, prevent the device from moving out of place. In using this device, the operator does not leave his seat, but is able to slide the frame along from one hole to another.

QUESTIONS FOR THE CAR INSPECTOR

Every car inspector must be familiar with the Rules of Interchange, the Loading Rules and the Safety Appliance Rules, and daily he is confronted with a variety of problems involving all of these codes. Some of these recur so frequently that their solution becomes almost automatic, but others come up only occasionally and sometimes in such form that the proper action is in doubt. A study of the following questions and answers may help in the solution of some of these questions when they next present themselves.

Interchange Rules

Question—For what purpose is the billing repair card used?

Answer—A billing repair card must be made out when repairs are made to foreign cars.

Question—What general practice should be adopted when making repairs to cars?

Answer—Repairs should be made promptly and should conform in detail to the original construction except as provided in Rules 17, 18 and 87.

Question—What is the standard height of couplers?

Answer—For empty cars, 34½ in.; for loaded cars, 33½ in.

Question—How should coupler heights be measured?

Answer—From the top of the rail to the center of the coupler head.

Question—Who is responsible for advertisements on cars in interchange?

Answer—The delivering company is responsible.

Loading Rules

Question—What rule should be observed in selecting flat cars to be used as idlers?

Answer—Flat cars of wooden construction must not be less than 80,000 lb. capacity, except that 60,000 lb. capacity may be used if equipped with inverted truss or steel centre sills.

Question—What rule governs the width of overhanging load on single cars?

Answer—Rule 11 of the American Railroad Association loading rules. The width of overhang should not exceed the following dimensions:

Length of overhang (C)		Width of Load (W)	
Ft.	In.	Ft.	In.
9	0	9	5
10	6	9	2½
12	0	9	0
13	6	8	9½
15	0	8	7
16	6	8	4
18	0	8	1
19	6	7	0
21	0	6	4
22	6	5	8
24	0	5	0

If the height of the load exceeds 12 ft., subtract 2 in. from the given width of load for every inch of height in excess of 12 ft.

Question—How is overhang measured?

Answer—From the center of the truck to the extreme end of the overhang.

Question—What specifications are quoted for stakes, clamping pieces, bearing pieces and braces?

Answer—They must be good, straight grain lumber free from knots that impair the strength, preferably hard wood lumber. They may also be rolled or built up steel sections of equal strength. Care should be taken to see that stakes do not spread at the top while cars are being loaded. In no case should the width of the load exceed the width of the car.

Question—What is the proper size for stakes?

Answer—Unless otherwise specified, stakes for flat or gondola cars with sides less than 30 in. high must be 4 in. wide by 5 in. deep or green saplings 5 in. in diameter at the center. For gondola cars 30 in. high or over, stakes may be 4 in. wide and 4 in. deep or green saplings 4½ in. in diameter at the

center. All stakes must be properly tapered at the ends to fit the stakes pockets and extend through and completely fill the pockets.

Question—Is it permissible to place stakes on the inside of gondola cars?

Answer—Yes, providing the sides of the car are 30 in. high or over. Stakes must rest on the floor and be wedged substantially to the car sides by the lading.

Question—What method should be followed when reporting dimensions of stakes?

Answer—The figure representing the width should be reported first and the figure representing the depth second. Width is measured parallel to the side of the car and depth at right angles to the side of the car.

Question—What should be done when the dimensions of stakes are smaller than the stake pockets?

Answer—Wedge the stakes tightly in the pockets by driving in wedges from the top and nailing them to the stakes. Unless the wedges are nailed to the stakes they will work out when the cars are in motion.

Question—How should stakes be fastened to prevent spreading at the top?

Answer—When boards are used there must be two boards for each pair of stakes. The boards should not be less than one inch by five inches and securely fastened at the ends to the stakes by not less than three tenpenny wire nails. When wire is used, unless otherwise specified, it must be equal to six strands or three wrappings of good 1/8-in. diameter wire. Wire must be secured to prevent slipping.

Question—Is it permissible to substitute wire heavier than 1/8-in. in diameter?

Answer—Yes, 3/16-in. wire may be substituted, in which case two strands or one wrapping of 3/16-in. wire will be equivalent to six strands or three wrappings of 1/8-in. wire. Four strands or two wrappings of 3/16-in. wire will be equivalent to ten strands or five wrappings of 1/8-in. wire.

Question—On cars offered in interchange, who is responsible for the application of the additional stake pockets necessary to apply stakes in accordance with specifications?

Answer—The delivering road is responsible and if applied by the receiving road the expense may be billed against the delivering road.

Safety Appliance Rules

Question—Is it permissible to weld uncoupling levers?

Answer—The safety appliance laws do not prohibit welding of uncoupling levers but the American Railroad Association, Section III—Mechanical does not approve of, and prohibits such practice.

Question—Is there a specified design of uncoupling lever?

Answer—No. Any efficient design may be used, either single lever or lever extending the full width of the car. On tank cars without end sills the uncoupling lever must not be less than 42 in. long.

Question—Where should uncoupling levers be located?

Answer—One on each end of the car. If the single lever is used it must be placed on the left side of the end of the car when facing the car.

Question—What further is specified relative to the location of uncoupling levers?

Answer—Handles must not be more than 12 in. from the side of car, preferably 9 in.

Question—What is the proper length of uncoupling lever handles?

Answer—Not more than 15 in. nor less than 12 in. long.

Question—How much clearance must uncoupling lever handles have?

Answer—Handles must extend at least four inches below the bottom of the end sill, or be constructed so as to have at least two inches clearance.

Question—What is the proper length of the center lift arm?

Answer—Not less than 7 in. long. The center of the eye in the end of the lift arm must not extend more than 3½ in. beyond the center of the eye in the coupler lock lift.

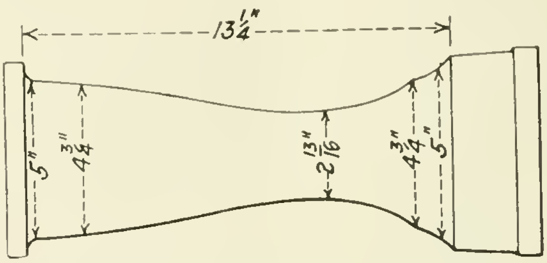
Question—How should rocking or push down type uncoupling levers be arranged?

Answer—They should be applied so that the handle will not be less than 18 in. from the top of the rail when pushed down to the position where the lock lift releases the knuckle. A stop must be provided to keep the inside section in position in case of breakage.

AN UNUSUAL HOT BOX

Journals burned or twisted off due to overheating are of such common occurrence that they cause little comment, but when a journal runs without breaking off until the diameter is reduced from 5 in. to 2¾ in. and the length increased from 9 in. to 13¼ in., the circumstances are sufficiently out of the ordinary to deserve some notice.

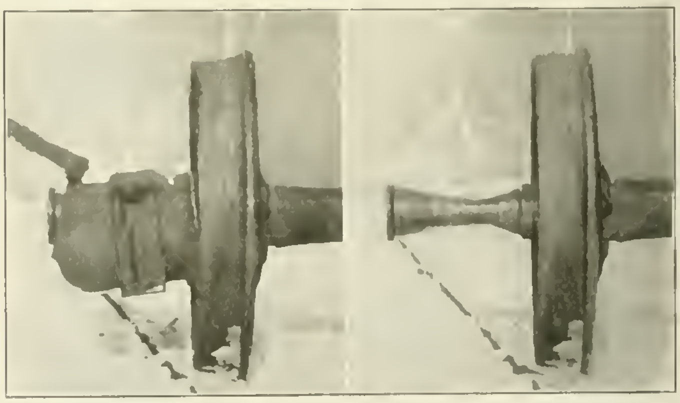
Some time ago, when looking over a train from Kansas City, an inspector on the St. Joseph & Grand Island at St.



Dimensions of the Journal When Removed

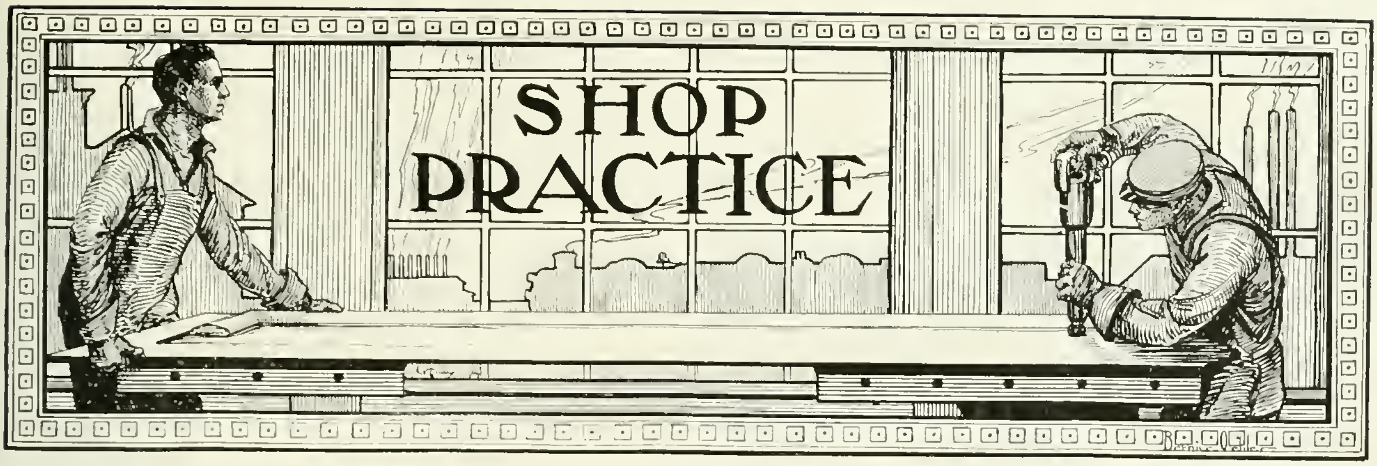
Joseph, Mo., discovered a journal with the end sticking out of the box. The journal was a cherry red and all the babbitt had melted out of the brass, yet the journal was not bent, although the car was loaded. The train crew stated that they had moved this car from Kansas City to St. Joseph, a distance of 61 miles, without experiencing any trouble and that no attention had been given the car between the two points.

On removing the wheels the axle was found to have been



The Elongated Journal, With and Without the Journal Box

drawn down as shown in the sketch. The 5-in. by 9-in. journal had been lengthened 4¼ in. and tapered from 5 in. at the shoulder outside of the wheel and just inside of the collar down to 2¾ in. in the center of the journal, almost as perfectly as if it had been turned to this shape in a lathe. It was drawn out without any loss of metal, as the weight was the same as that of a second hand axle after it was removed and weighed. Both ends of the brass were worn off until there was only 5 in. of the 9-in. brass left, which had its bearing on the smallest part of the journal.



WELDING A WORN DRIVING WHEEL FLANGE

The value of oxyacetylene welding is becoming more and more evident in every industry where the repair of machinery is necessary. One of the recent examples of the economical advantages of the process is shown in the repair of a worn driving wheel flange on a passenger locomotive of one of the large railroads. The flange in question was on one of the rear driving wheels and had been badly damaged by contact with a defective brake shoe.

Ordinarily in a case of this sort it is good shop practice not only to turn down the worn tire, but the other tires of the locomotive as well in order to reduce all of the wheels to the same diameter; or, if they have already been worn to the limit, to replace them with new tires. This work is expensive. Usually a week is required to remove, machine and replace driving wheels. A longer time is necessary where new tires are applied.

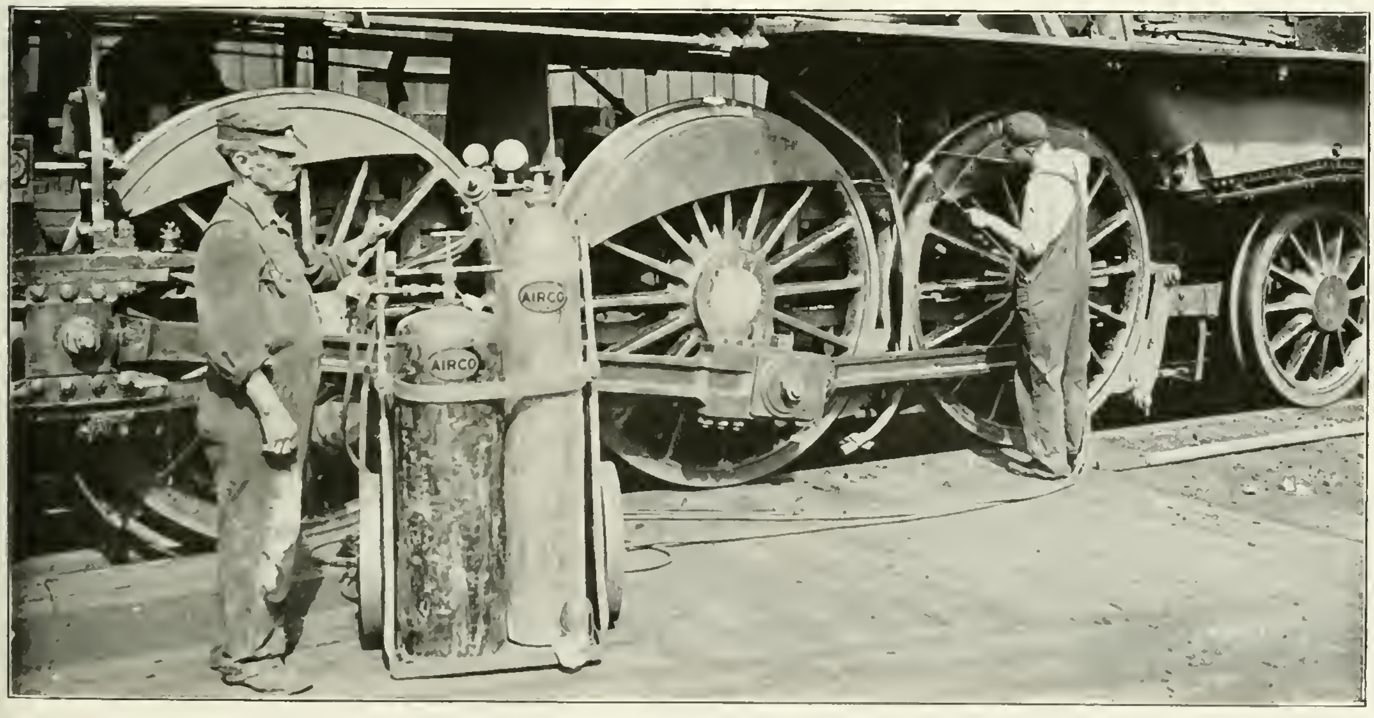
In this particular case the tires had received their last turning, making it impossible to repair the flange in this way. To renew the wheels with an entire new set of tires would have meant the waste of about six months' wear still obtainable from the old tires.

The master mechanic in charge of the shop decided that the worn flange could be built up by their Airco welding torches and accordingly set to work to repair the flange, leaving the driving wheel in its usual place under the engine.

Value of six 72-in. diameter driving wheel tires with a period of life equivalent to that of the six worn tires on the locomotive; cost of replacement, etc.		$625.00
Oxygen	$5.00	
Acetylene	8.75	
Welding rod	3.00	
Labor of welder and two helpers	22.64	
Total cost of welding	$39.39	
Scrap value	90.00	
Total cost of repairs		129.39
Net saving		$495.61

The side rods were removed, and rollers ordinarily used for setting valves were placed under the wheels in order to revolve them as the welding work progressed. After the weld was finished the flange was ground with a portable surface grinder.

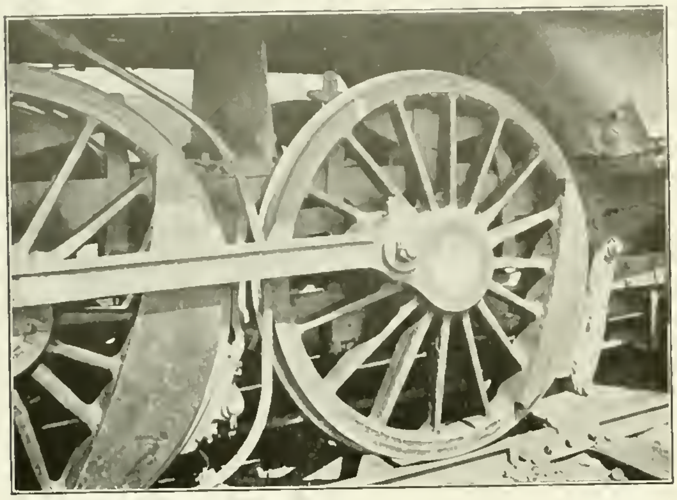
The work took twenty hours, the locomotive being put back on its regular run at the end of that time. Several



Welding the Worn Flange Without Removing the Wheels from the Locomotive

days of locomotive service were saved, not to mention several hundred dollars' labor required if the wheels had been dropped. Cost details are shown in the preceding table.

The welding of the tire took place more than five months ago, and the locomotive has been in continuous operation



The Appearance of the Flange After Welding and Grinding

since that time. When inspected recently it was found that despite the strain to which this part of the wheel is subjected, the welded flange showed only a normal wear.

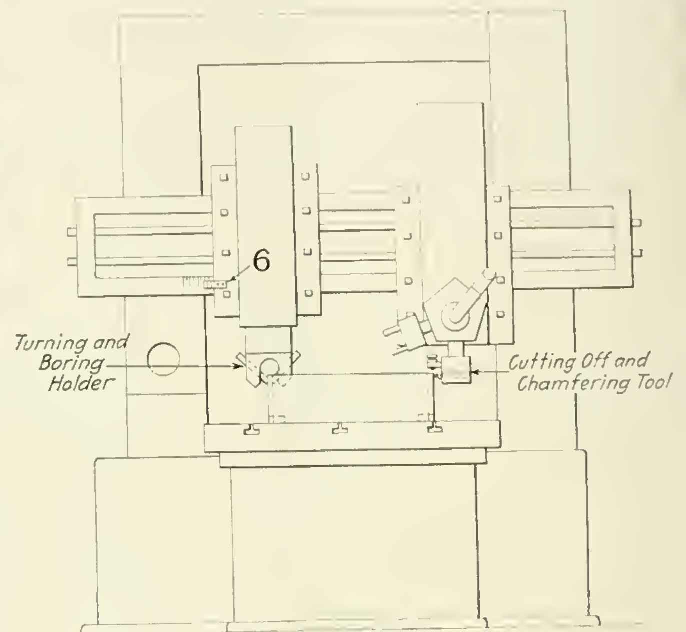
TOOL HOLDERS FOR MACHINING PACKING RINGS ON A BORING MILL

BY E. A. M.

An attachment to a boring mill, which makes it possible to perform three operations simultaneously, is shown in the drawing. With this device packing rings can be turned, bored and cut off at one setting, thus increasing the capacity of the mill and materially reducing the cost of production.

The boring and turning tools *5*, which are made of one-

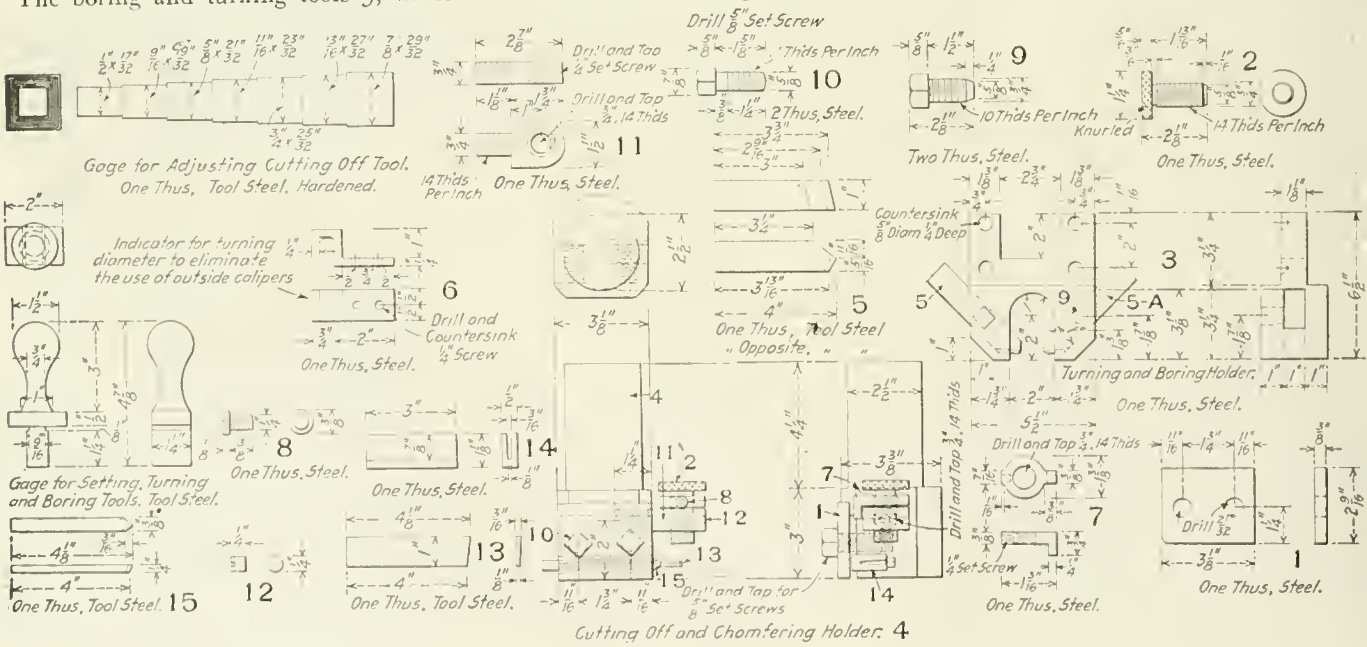
by the screws *10*. The adjustable guide *11* is screwed into the side of the holder *4*, and in turn holds in place the screw *2*, which is screwed down through the holes in the guides *7* and *11*, and is locked in position by the small screw *12*, which screws into the end of the guide *11*, and by the screw *8*, which screws into the guide *7*. By this arrangement the holder *1* also acts as a lock on the cutting-off tool holder. The screw *2* reaches to and rests on the part to be machined and the cutting-off tool is then properly set to produce the



Boring Mill With the Holders Applied

size of ring desired. After one ring is cut off the tool is lowered the thickness of a ring and another one cut, repeating the operation as often as desired or the stock will permit.

The steel piece *6* acts as an indicator for turning the required diameter of ring and eliminates the necessity for using an outside caliper. As will be seen in the drawing of



Details of the Tools, Tool Holders, and Gages

inch square tool steel, are secured in the holder *3* by the set screws *9*. The chamfering tool *15* fits into the narrow part of the slot in the holder *4*, and the cutting-off tool *13* is placed in the grooved holder *14*, which is held in place in the holder *14* by the plate *1*, which is secured to the holder *4*

the boring mill, this indicator *6* is fastened on the borin head and a number of lines are scribed on the cross ra of the machine to provide for convenient and accurate adjus ment of the indicator. Gages for setting the boring and tur ing tools and for adjusting the cutting-off tool also are show

The Labor Situation Today and Tomorrow*

Creation of an Incentive Will Stimulate Production; More Conciliation and Optimism are Necessary

THE labor problem today is universal and there has been so much thought given it and so much said regarding it that it is difficult to do more than reiterate salient facts which have crystallized out of the general problem.

A situation confronts us today unlike any before experienced, and to counteract its effect it is essential that its significance be fully appreciated, as it will call for the full efforts of all who believe in democracy and the maintenance of democratic ideals. The influence which is now being brought to bear to undermine the social structure of the world is making itself felt through many other channels than labor, but it has undeniably had a tremendous effect on labor conditions.

During and following the crisis through which the world has just passed, the laboring man, forced by the high cost of living, sought to better his position, and, influenced by propaganda, he directed his efforts not only toward increased wages but on a reduction in working hours, and the results are fast leading to another and even greater crisis. When hours decreased, production decreased; the unit of production cost more to create and the employer was forced to increase his price to the consumer in order to maintain his income, with the result that the value of the dollar depreciated proportionately and the situation was relatively the same as prior to the initial change. This decrease in production, however, had another effect. It required that more labor be employed to obtain the same output, and the natural result is the present shortage of labor.

It is recognized that it is not possible to realize the same production in the eight as in the ten-hour day, but had this been possible it would not have been necessary to increase prices, the cost of living would not have increased, the value of the dollar would not have decreased, and the world in general, but the laboring man in particular, would have been greatly benefited. As long as wages are advanced and production decreases or even remains the same, the cost of living must necessarily increase and the circle becomes endless. It is absolutely impossible for the laboring man to make headway against the cost of living by the methods that are being followed today. The one and only relief is increased production. Germany has already realized this fact and her workingmen have voted for the eleven-hour day in order that production may meet the demands and again permit them to wage the fight for commercial supermacy. How this increased production is to be obtained in America, however, is the real problem of the present time.

It is apparently necessary first to stimulate production by creating an incentive to produce. We cannot today outline a method that may be pronounced "best," but some manufacturing concerns are now trying methods which will, no doubt, create an interest on the part of the employees in the success of the business. It will probably be very difficult to apply any plan that is being tried at the present time to the railroads on account of the diversity of work and the extent of the territory they cover, but out of the numerous plans that are being tried one should be evolved which will gain the desired results, and the mutual efforts of employers and employees along these lines can, without question, create a successful plan.

In connection with any campaign to increase production it will be necessary to undertake a thorough and systematic education, applied particularly to those who have come to us from foreign countries and who speak our language but poorly, and who do not understand our institutions and our ideals. Their very misunderstanding creates fertile soil for the growth of radical ideas that are the subject of a systematic and universal propaganda today.

If the evil is to be entirely overcome it will require the combined efforts of every loyal citizen of America, it will require that citizens exercise fully and properly their right of franchise; that responsible, reasonable men may be elected to offices in our city, state and national government. While it might be supposed that this is universally recognized, the fact remains that throughout the entire United States educators are being forced to leave their stations and accept more lucrative positions in order to meet the present increased cost of living, and our city governments are not taking steps to remedy this evil. Education is the best antidote for radicalism, though without doubt it will not be effective in all cases. Steps are under way now, however, to cope with the radical leaders through proper legislation, and such legislation will probably be made effective in the near future so that our immediate attention might be turned to the followers rather than to the leaders.

By education is meant the broad sense of the term, not merely class-room teachings of the English language, but instruction in American institutions, ideals and the spirit of fair play, and it is suggested that the man on the ground, that is, the supervisor who comes in closest contact with the working man, can accomplish far more in this respect than any one else. By keeping in close touch with his men; providing for their needs; listening patiently to their grievances; always applying discipline when necessary, but only when necessary, and then only after the man concerned has been given full opportunity to be heard and such discipline administered with the idea of saving instead of losing the man, he will gradually gain their full confidence and respect and his troubles from the labor standpoint will proportionately diminish.

There is a feeling on the part of a great many individuals that unionism alone is responsible for the present situation, and it is suggested that a more optimistic view of relationship with labor organizations and co-operation with them along reasonable lines will be quite effective in removing some of the present difficulties and eliminating some of the present feelings. Conciliation will gain more than opposition. The real cause of this feeling is, no doubt, the influence being exerted by the radical elements that constitute a small minority of present-day labor organizations, just as this influence is also being exerted in our political life. It can be counteracted most effectively by the older and more reasonable members taking an active part in affairs and exerting their influence to counteract the ill effect, just as our political life, the influence of the radical element may be eliminated by the full exercise of franchise on the part of the loyal citizens of the country.

When we are able to free ourselves of the radical elements, to properly educate others, to increase our production to meet or exceed present-day demands, to reach the point where the employer and employee will meet and discuss with reason their difficulties there will be little left of "the labor problem." This may appear to be an extremely optimistic view of the situation and may further appear to be so far in advance of present-day conditions as to be Utopian, but it is

*From a paper presented by Frank H. Hardin, before the Central Railway Club, March 12, 1920.

suggested that optimism is the prime requisite in the battle and that pessimism is always defeated before the fight begins.

Discussion

D. R. MacBain (New York Central) offered some suggestions for supervising officers. He stated that although the task of the supervisors seems hopeless, optimism is needed. He ascribed much of the present difficulty to lack of personal contact and the tendency on the part of the local officers to evade their responsibilities. To show that socialistic rule made conditions worse for the workers he cited the fact that Russian workmen are compelled to labor 13 hours, seven days a week. The dissemination of such information was urged by Mr. MacBain as a means of combating the tendency toward bolshevism.

W. O. Thompson (New York Central) argued that the keynote to the situation was getting closer to the men and gaining their confidence.

W. Flynn (Michigan Central) expressed the opinion that the labor problem is not insurmountable and that the solution lies in education and optimism.

F. C. Pickard (D. L. & W.) stated that the roads were now going through a transition period and the tendency is in the right direction. In his opinion, troubles could be minimized if an effort was made to adjust grievances with more promptness.

J. J. Rossiter (New York, Chicago & St. Louis) laid the blame for the present unrest on the radical element, whose slogan is higher wages and less work. As long as this propaganda is heeded it will be impossible to bring the cost of living down. Although strikes have recently been called off, it is doubtful whether the men are now giving fair production. Mr. Rossiter believed the remedy lay in the overcoming of the radicals by the conservatives in the railway labor organizations.

L. D. Gillet (Dominion Railway Commission of Canada) expressed the opinion that in the labor situation at present bolshevism of the worst type must be contended with, and inwardly many are viewing the problem with extreme pessimism. Labor has learned the strength of organization, and the situation is made worse by the fact that a small number of men who have been in the army have become agitators. One man of this type can have a bad influence on a hundred others.

W. A. Buchanan (D. L. & W.) submitted that if the principles brought out in the paper were applied every day a marked improvement would be effected. He suggested that the more general use o' machinery would aid in increasing production.

F. W. Brazier (New York Central) expressed the opinion that production has now decreased to the danger point. The present labor organization discourages direct contact between the officers and the men, and the incentive for production has been removed under present rules. The big problem is to restore the morale. The only salvation is in more production, and conciliation is needed to bring results.

C. L. McIlvaine (Pennsylvania) cited some examples of high production under present conditions, and stated that it is a mistake to condemn men as a whole for the acts of a few. Labor has suffered because of poor leadership, but the tendency now was to break away from the radical element, and he thought that a great improvement could be effected if the management did not antagonize the men.

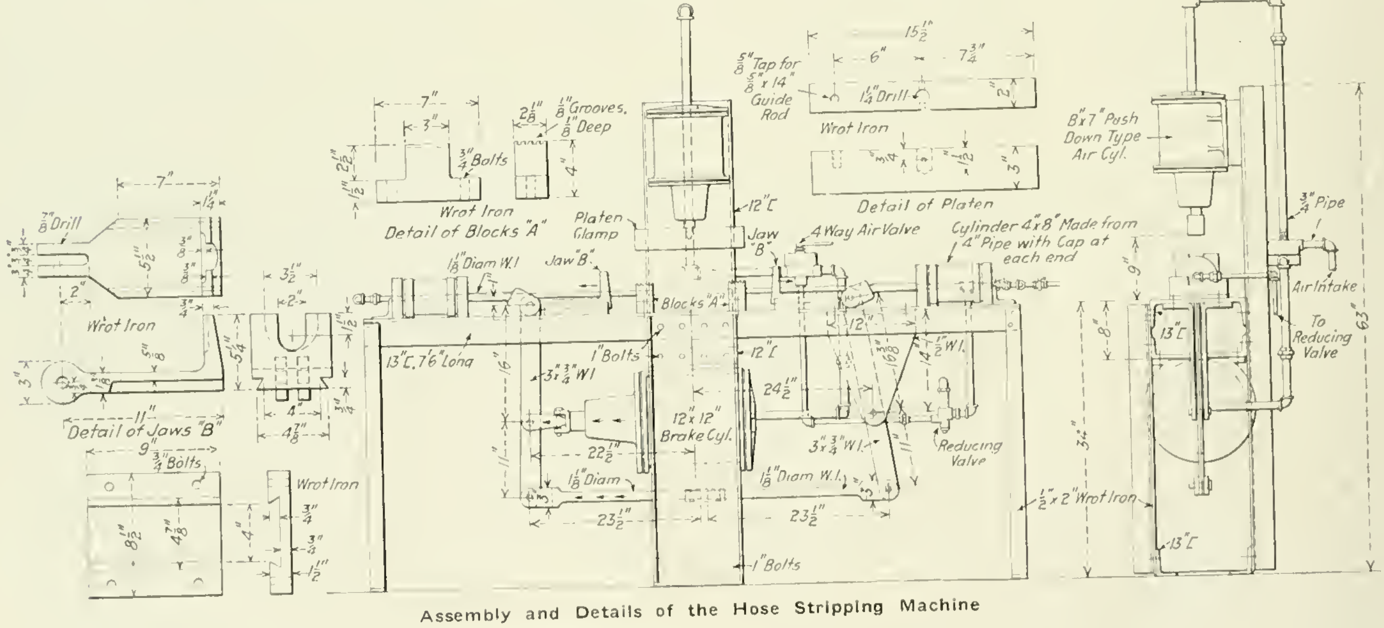
HOSE STRIPPING MACHINE

By R. S. H.

A machine for stripping the connections from old or worn out air hose is shown in the drawing. This device is operated by compressed air, controlled by a four-way valve, and is being used in place of hand methods in the scrap reclaiming plant of a Western railroad.

The construction of this machine is comparatively simple and it does the work quickly and efficiently. The hose is placed on the two blocks *A* with the hose connections slipped over the jaws *B*. The top cylinder is then filled with air and forces the platen downward, securing the hose firmly in place on the blocks *A*. This prevents slipping of the hose in case one of the hose connections should be freed before the other. The air is then turned into the lower cylinder, and through the system of levers, operating as indicated by the arrows, strips the connections from the hose. The small cylinders at each end of the bench act as cushions and absorb the shock when the connections suddenly pull out of the hose.

A machine of this type can easily be constructed and the speed and economy of operation have demonstrated its value over hand methods by a considerable reduction in the amount of labor required for the work and saving in the time required to strip a given number of hose connections from old and worn out air hose.



Assembly and Details of the Hose Stripping Machine

Graphic Production Control In Railway Shops*

Production Department Coordinates the Work of All Departments in Angus Shops of the Canadian Pacific

BY E. T. SPIDY

Production Engineer, Angus Shops, Canadian Pacific

IN the management of any industrial plant the author has become convinced through plain experience that apart from the personality of the management directing affairs and the regular accounting system there is a great need everywhere for the placing of facts in such a manner that the condition of affairs to-day can be seen quickly in their true relation to the policy of the management.

We are all more or less accustomed to seeing statistics shown graphically. Their value to show what has happened is of unquestioned value. We are able to see at a glance, for instance, how our expenditure on a certain class of output compares with last year and if we plot on the same sheet the amount of our output we are able to see how the cost has

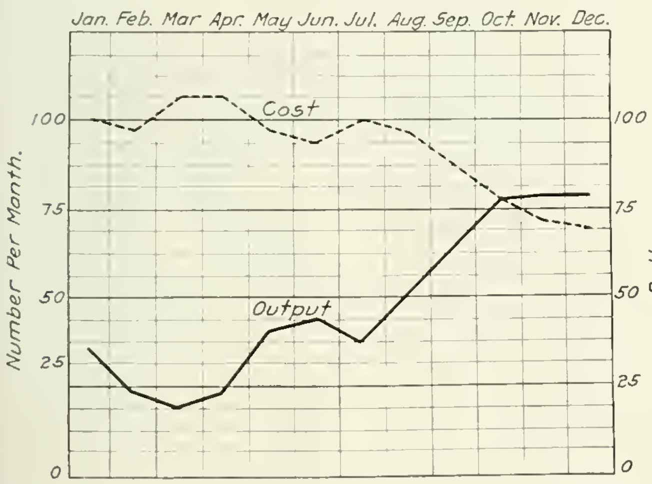


Fig. 1. Chart of the Type Used to Show What Has Happened

varied with the output. Such a diagram as shown in Fig. 1, is a familiar one and needs no explanation.

Let us suppose you have received a statement showing departmental expenses, or a statement of output in which an item shows lower than your expectations or the average. You see a condition that, had you known it was happening, you could have done something to correct, but all you can do now is to investigate and make such changes as your judgment dictates.

After you have received an explanation, censured your man or perhaps replaced him, what guarantee have you that you will not look at an even worse condition next month? The only guarantee you have is your confidence in the man in charge. This confidence I do not for an instant depreciate, because it is your mainstay with the most perfect system, but in this age of specializing would you not be better off and would not the individual departmental head or foreman be better off if you were to supply him with information on expenses or where he stands on his output, or other details, that is "up to the day of looking at it" so that he can control the situation to give you what you want?

Can this be done? It can if you organize to do it. You must assist the foreman by training specialists to perform functions that are at present part of his duties, better than the foreman can perform them because they concentrate on that particular object only.

Specializing needs no introduction; on our machines and operations we know a specialist can produce more than an all-around man on work adaptable to specializing. We would not think of having the same boilermaker who puts a patch on a boiler roll in tubes, for the same reason specializing applies in management questions. A few concrete examples will show how graphical production methods permit a specialist to perform functions that assist the executive by supplying information that is up-to-date on what is causing delays or what will cause delays.

Locomotive or Passenger Car Repair Costs

The first case is a shop repairing locomotives. The methods apply equally to a passenger car repair shop. The object is to assist all foremen to plan their work so that delays to output are minimized. Analyzing the shop, there are 30 departments, all receiving some part of each engine or car to repair and on each of which rests the responsibility of having that part ready at a certain time when the process of erecting demands it. Based on the road report and a preliminary inspection, the scheduleman and the general foreman of the shop determine that it will require so many days to complete. This period is determined by adding together the time required on all the various detail jobs known. From past experience we have developed a series of schedules from 9

MONTH OF Oct 1919 REPAIR SCHEDU

OPERATION	1572	465	5165	2211	1482	5113	462	2118	1113	918	2858	1212	542
WASHED							25	25	30	2	2	3	4
CARP. WORK START.							29	29	1	3	3	4	7
CARP. WORK COMPL'D	26						30	30	3		4	7	9
PRIMED	27	23		24		24	1	1	4	6	6	8	10
OILED				26			2	2	5	7	7	9	11
FILLED	30	25		27		26	3	3	6	8	8	10	13
SURFACER #2 (GREY)	1	26		29		27	4	4	7	9	9	11	14
PUTTY NAIL HOLES	2	27		30		29	6	6	8	10	10	14	15
1ST SURFACER #2 RED	3	29		1		30	7	7	9	11	11	15	16
2ND SURFACER #3 RED	4	30		2		1	8	8	10	13	13	16	17

Fig. 2. The Master Schedule

to 30 days each, one of which is applied to each engine or car as the work demands. The locomotive repair schedules are practically all based on one 18-day schedule, in that on all engines the operations for the first five days and the last seven days are practically the same, the time between being taken up by the department having the excessive or special work to do.

We now come to our first chart which is called a master schedule. The master schedule forms, shown in Fig. 2, have listed down the left side all the controlling detail operations or parts in the sequence in which they must be completed. At the top of the vertical columns each engine or car number is entered as it is taken in the shop, and then by the applica-

*Abstract of a paper read before the Canadian Railway Club, January 13, 1920.

tion of the selected schedule the date it is required completed or delivered is entered opposite each operation. When this is done the second form, called a date schedule, is made out. This is identical with the master schedule except that the days of the month instead of engine or car numbers are placed at the top of the columns and in the column for the date as entered on the master schedule is inserted the engine or car numbers opposite the various operations. By a four color code exactly what has happened is entered on both charts every day, showing whether "on time," "shop late," "material delivery late," or "drawings late" in black, green, red or yellow respectively. At a certain time the schedulemen make a check of all shops, after which they mark up the master and date schedules. Following this they make out from the date schedule, for each departmental foreman, a list of operations due completed to-morrow and include on it, especially marked, all items that are late. This daily "order of work" sheet is delivered to each foreman the night before the day it covers, so that he can plan his work to cover every item. Incidental to this, a list of all late items in all shops is prepared for the general foreman and superintendent in order that they may use their influence to prevent further delays.

We thus have before us a graphic record of the progress of each engine or car showing each delay as it occurs, from which weak points can be seen at a glance. The result is co-operative effort because each department realizes that the management knows what is going on and can measure each man's effort. It makes it unnecessary for foremen to leave their shops to trace material, this being part of the scheduleman's duties. When extra work is found necessary, thus setting back the original date of delivery, the change is automatically taken care of by the production department.

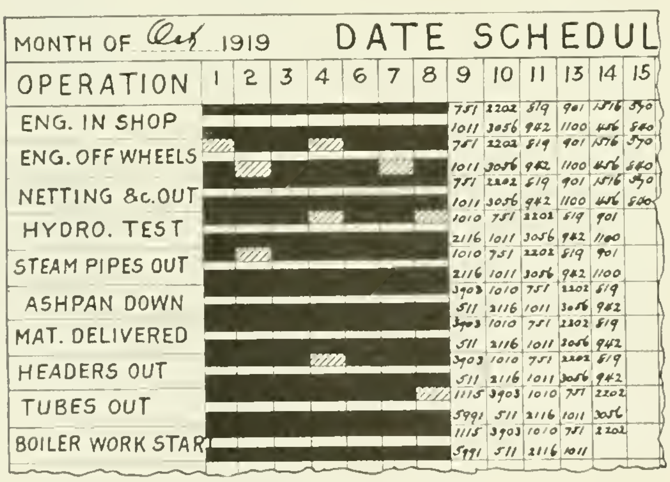


Fig. 3. The Date Schedule

The net result is a shorter number of days in the shop per unit, the time between jobs is reduced and costs are lowered.

Locomotive or Passenger Car Repair Costs

It is important that we know certain detail costs at current periods. Costs do the shop little good if they come when the job is completed. The method used is suitable for all classes of work where average costs are maintained and used as a base for expenditure. It is not recommended in this form for manufacturing small articles or a quantity product.

Fig. 4 is a graphic representation of current locomotive repair costs. On the left is a scale of dollars large enough to cover the anticipated range. Each vertical column is headed with the engine number; the date it came in the shop and the class of repair is also inserted for reference. By arrangement with the cost department these daily costs are given preference and are supplied the second day after they are incurred on a special form for the purpose, and on the cost chart a black line is extended daily under each engine to show the total cost to date. In each engine cost column a red cross line is drawn at a point opposite the estimated cost of the job. An estimate is made for each engine, based on an average in the case of straight repairs, as soon as the inspection is complete. Included in this are the allowances necessary in the case of extra or special repairs. Now when an executive looks at the chart he notes particularly those engines that have gone past the red mark and by referring to the engine master schedule he sees what has happened and the progress of that particular engine. He is then in a position to act if his judgment indicates that the cost is abnormal.

It will be noted that short thin black lines extend from each engine cost line at more or less irregular intervals with a number close at hand. These lines are to indicate the amount added each day, the number representing the date. We can thus see whether the labor expended has been irregular, or whether it is a steady growth. This is a clear indication of good or bad organization in the shops. Great use can be made of this chart. It shows poor distribution of labor in detail and enables conditions that bring about high costs to be analyzed thoroughly and acted on before the question is asked.

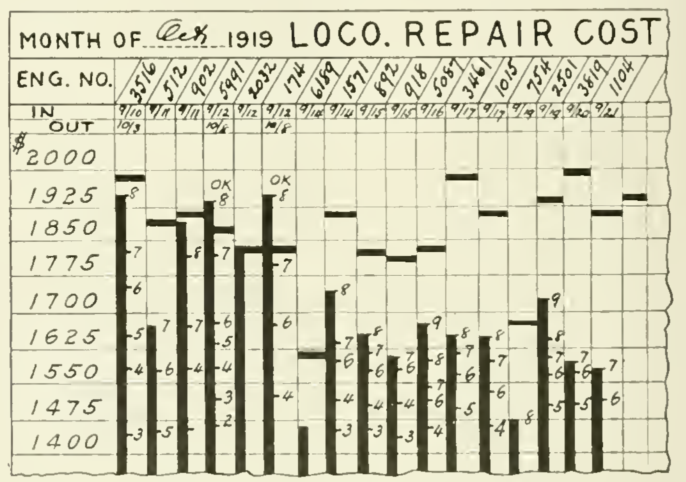


Fig. 4. Chart for Recording Current Locomotive Repair Costs

Cost of Manufactured Material

It is desirable to know the efficiency and cost of each order for manufactured material up to date during its progress through the shops. The method described is used by manufacturing concerns, who have found that the way to control costs is in the shop while the job is in progress, and it is applicable to railroad back shop manufacturing.

It consists of a job cost sheet which is kept in the shop office. These sheets are kept in loose-leaf book form and the duties of the cost clerk are to enter in the proper column, from the daily time cards, the costs incurred during the previous day. By noon the cost of each order up to the previous evening should be entered. On each sheet is detailed the standard method of doing the job and the standard time allowed for each operation. This information is obtained from the production department which develops the correct method, working with the shop engineer and the foreman of the department, who at the same time recommend such special jigs and tools as may be deemed necessary. When the order is unusual or rare enough not to warrant making standards for further use, a summary estimate is made up for each operation by the production department in order that a daily check may be kept on the job.

The duty of the cost clerk is to call the attention of the foreman or the party concerned when the cost exceeds the

allowance up to the point in its progress which the order has reached. The foreman is thus kept posted on the cost of each job at all points of its progress, not after it is done and too late for him to do anything about it.

Major Account Expenditure

Fig. 5 is a form used to show graphically a summary of expenditures on major accounts. This type of form was developed by the late H. L. Gantt and used effectively to record progress of airplane and munition manufacture in his work for the United States government during the war.

We want to know how our daily expenditure on each account compares with the allowance for the day, also how

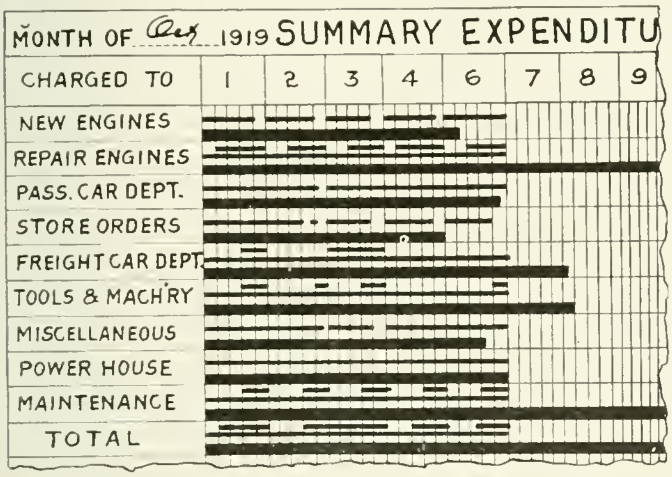


Fig. 5. Current Summary of Major Account Expenditures

our total expenditure to date compares with the total allowance to date on each account. The chart contains one vertical column for each day of the month, over which the date is inserted. On the left hand side the name of each account is inserted. We then calculate the allowance for each working day of the month and enter it for reference on the right hand side of the chart. The distance horizontally between each date column represents 100 per cent of the daily allowance figure, and as the actual expense figures are received, a line is extended across this space equal to the amount actually expended. If this is less than the allowance the percentage of this line will not cover the space, if more than the allowance an extra line over the one covering the space shows how much. Directly under this line representing the daily expenditure is a thicker line which represents summary cost to date. This line is merely extended daily by the same amount as entered under the daily cost column, except that it shows by its total length whether the account is over or under expended to date.

While this sounds somewhat complex it really is extremely simple in operation and furnishes a complete record of how much, when and on what accounts we have over or under expended. The chart is soon readable by any one and shows immediately how closely instructions are being attended to. The idea is one of vast possibilities aside from costs whereever units and summary data is required.

Detail Operation Schedule

Fig. 6 illustrates a method used by the author to plan the work for every productive man and machine in a department. The shop control board contains a separate slot for every man or machine, the identification being placed down the left side. As each order is received by the production department a ticket is made out for each operation equal in length to the time allowed for the operation. The tickets are made on profile paper with 20 divisions to the inch, each division representing one hour. The board is black with vertical white lines at weekly intervals. In the top slot is located the date strip, showing days of the month for the period covered on the board. All the work for the shop is represented on the board, each operation being located in the proper slot. When material is available each operation from the first to the last is located in its respective slot at the proper date so that time between operations is reduced to a minimum, taking into account also the continuity of work in each machine. Simultaneously with the making of the control board tickets a job card is made for the shop foreman's office board. This board contains a compartment for each man, and the cards are arranged to correspond with the master control board with the "next job" card always in front. As each man nears completion of the work in hand his gang boss goes to the board and takes the "next job" ticket, and gets the material and the necessary tooling equipment to the machine. The card stays with the work and then goes to the inspector, who, after inspection, passes it to the cost department. This system plans the work in detail for the foreman. It shows when machines are overloaded, when they are idle due to breakdown, man absent or out of work, all points of vital interest where costs and delivery are of prime importance.

There is one fundamental principle underlying all these

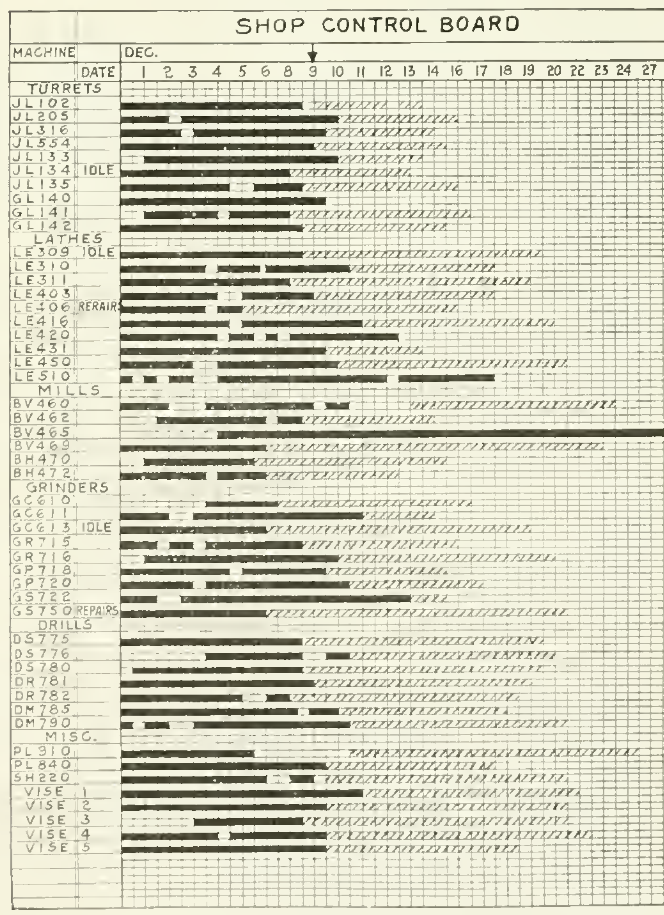


Fig. 6. Shop Control Board for Laying Out Machine Work In Advance

methods. In every case a standard or task is set as the object to be attained and that standard is set at the beginning of the job. All the methods provide a means of knowing whether or not the standard is maintained at all points in the progress of operation up to the completion of each particular task.

Each example given has been preceded by a statement as to the object to be attained. This is very important because the multiplicity of details which have to be dealt with will

often lead one off the track unless the purpose is kept steadfastly in mind.

It should be noted that while all this looks like so much clerical and accounting work, the viewpoint is not that of an accountant, nor could it be handled by an accountant; it is distinctly a management engineering proposition for an engineer.

The principles outlined have been adopted by the management of the Canadian Pacific in the creation of a special department, called the production department, attached to the chief executive of Angus shops. It is distinctly a new department for railroad shops and credit must be given to W. H. Winterrowd, chief mechanical engineer, for recognizing that there was no logical reason why methods of successful business institutions should not be incorporated into railroad shops. To the best of the author's knowledge, the Angus shops are the only railroad shops on the continent that have such a department, operating as a separate department with the full confidence and co-operation of the supervising staff, all working for one result. All foremen, general foremen, and other supervisors realize that one department, acting as a sort of clearing house for all material, can render better service than was possible when they each had to chase their own material from shop to shop. They also recognize that when a certain output is required, the special department can advise what operations are to be done each day, can advise on all items, and state what must be done daily so that the final result meets the requirements, because it has more complete information than any one department could possibly have or get. In all cases the basic schedules are developed by or with the departmental head concerned so that he feels that it is his schedule and consequently he realizes that he is being actively assisted by the management.

Discussion

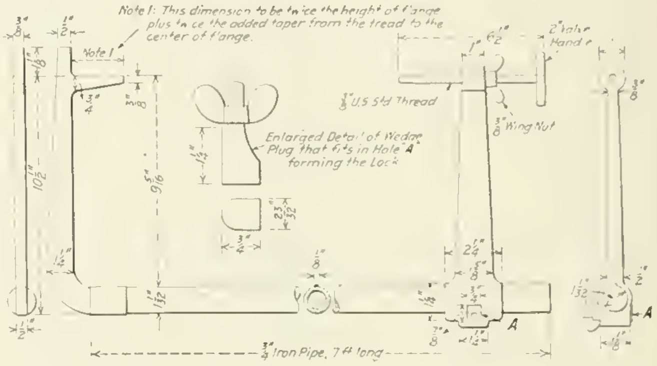
The discussion of the paper brought out the fact that the scheduling system requires a very small staff to operate, as in a shop employing about 2,500 men, not more than four or five additional men are required to take care of the work created by the system, while a 50 per cent increase should be obtained in the output of the shop without increasing the supervision. The question as to the effect upon the scheduling system should piecework be discontinued was answered by Mr. Spidy, who said that the schedule system in itself is entirely independent of the piecework system. Should piecework be discontinued the check on individual operation obtained by the piecework foremen would be discontinued, but there would still be the check in every department which is made by the production staff in each shop. The discontinuance of piecework would probably result in some of the piecework staff being absorbed into the supervision, thus providing extra foremen to check up the work and see that it is performed. Mr. Spidy stated it as his opinion that a shop without piecework requires a production schedule that is more extensive than one operating with piecework, because of the loss of the check on the work of the individual which is obtained with the piecework system. The distinction between the schedule system and the piecework system is that the former cuts the time between jobs while piecework concentrates on the job itself.

J. Burns, works manager, Angus shops, C. P. R., emphasized the necessity for a schedule system in a large shop especially where equipment is being built and large quantities of material must be secured and routed through the shop in proper sequence. He also emphasized the importance of the scheduling system where the same shops are manufacturing parts for use on locomotives and cars in the erecting shop as well as on shop orders for outside points. The schedule determines the proper preference to be given the different classes of work so that in neither case will delay result through failure to meet conflicting requirements.

TRAM FOR DRIVING WHEEL TIRES

BY H. L. LINGO

The form of tram shown in the illustration is a great convenience for sizing driving wheel tires either in the lathe or on the boring mill, as the straight prong on the fixed head gives the exact size to turn the flange when the tram is set to the tread size. There is no chance of error, and either not having quite enough stock to make a proper flange or having to reduce stock with the throat of the flange former, which is a difficult job. The practice of finishing the tread of the tire to size, then drawing the tool back the required distance and cutting off the top of the flange, after which the flange is formed, is still in use in many shops. This can be changed and, on a boring mill with two tools



Construction of the Tram for Driving Wheel Tires

working at the same time, where it is known just what the height of the finished flange will be, it can be roughed out and finished with one head, while the other is roughing down the tread.

The wedge block which holds the movable head in place is nothing new, except in its application to the wheel tram, where it replaces the familiar set screw which usually was not even provided with a shoe to keep it from denting the pipe, and after it was in use for a while required all the tools most of the railroad machinists use at present—hammers and monkey wrench—to operate.

Disk and Ball Bearings.—Exhaustive tests of disk bearings and ball bearings in railway service are being carried out in Sweden. Disk bearings have been used in one of the trucks of a passenger car which has made over 31,000 miles. The car weighs 36 tons, the weight on each journal being four and a half tons. A new type of ball bearing has been developed for railway service and in the laboratory of the manufacturers, bearings of this type have withstood a pressure of 20 tons during a number of revolutions, corresponding to more than 30,000 miles.

Ethylene for Cutting and Welding.—According to the Scientific American, comparative tests have shown that ethylene is a good substitute for acetylene in cutting and welding operations. As far as heat of combustion is concerned, ethylene has a slightly higher co-efficient. Moreover, in the working of copper it has been found impossible to make a satisfactory weld with acetylene, because of the formation of carbon and the consequent blistering in the weld. This is not the case with ethylene. In addition to its availability for welding copper, the ethylene process of aluminum welding and lead burning makes for much better results than does the use of acetylene. Finally, ethylene has been found to possess considerable value for heating and lighting and is, therefore, a general purpose gas.

J. D. Blount Tries a Novel Experiment

The S. M. P. Knew that Tom Brown Was a Good Man but Also that Ashville Needed Waking Up

BY A. N. BUCKLEY

When T. B. Shoan entered the Old Man's office he knew instinctively something was in the wind. J. D. Blount, the superintendent of motive power of the Buffalo & North Eastern, sat at his desk gazing out of the window wrapped in thought, oblivious to Shoan's customary "Good morning." T. B. Shoan busied himself arranging the morning's correspondence for Mr. Blount's perusal, picked the papers from the outgoing basket and attended to other routine matters, knowing from experience that "J. D." would speak his mind in due time.

As he turned to leave, J. D. spoke. "Shoan, have you noticed how the B. & N. E. has been increasing its maintenance of equipment expenses, especially in repair costs, at Ashville shops? Ashville has one of our best shop superintendents, Tom Brown, but something has gone wrong lately. Output has fallen and costs have gone way up. The power to be maintained at Ashville has not changed, our shop facilities are the same, and while the increased labor costs would cover part of it, the combination of decreased output and increased costs demands a different explanation. Only two things can account for the condition—lack of proper organization and insufficient attention to improved methods and practices.

"Arrange for Brown to Spend a Week at the D. & O. Shops"

"Organization," continued J. D., "is absolutely essential to effective working of every plant. Proper organization means more than smooth co-ordinated efforts between foremen and the shop superintendent. It requires developed and trained responsibility and the fitting of understudies for everybody, from the shop superintendent to the errand boy. No man is big enough for his job who is afraid to train some one to take his place. The real executive is not necessarily the man who knows the most, but the man who can command the services of and direct the efforts of men more capable than himself.

"Efficient operation requires the continued study of better shop practices, intensive utilization of facilities and the elimination of all possible lost motion. Effective watching of operation demands the assistance of records which will serve as the control factors of the shop superintendent.

"So to test my belief as to the underlying causes of Ashville's conditions, I have in mind a novel experiment. Arrange to have Tom Brown leave Wednesday evening to spend a week at the Mountain Dare shops of the D. & O., another week at the Johnston shops of the R. & P., and a third week at the West Brook shops of the N. T. C. That gives him less than 36 hours to get away, and unless he has a developed organization it will not enable him to completely plan operations during his absence. Then tell him on his return to report the results of his observations as applicable to Ashville's shop improvement."

When Tom Brown received the Old Man's instructions he was dumbfounded. Things were as Blount had suspected. Brown had a one-man organization — and Brown was that one man. Bill Scott, his general foreman, had often tried to assume part of the load of management, but Brown, one of the old school, ever jealous of his prerogative, had resisted all of these overtures. Consequently he was at a loss just what to do, realizing that the time at his disposal was insufficient to instruct his organization for the next three weeks' operation. However, he knew J. D. B. well enough to know that nothing short of implicit following of orders would suffice, so he decided to trust to luck and Bill Scott.

Results during the first week of Brown's absence were such as were to be expected. Bill Scott worked hard, but the task of assuming both Brown's duties and his own served as a heavy handicap. No understudies were available, so that he was unable to have a temporary general foreman. Visitors were slighted, correspondence attended to evenings, reports checked and certified at the expense of sleep in order that shop operation might be pushed during working hours, a task not altogether successfully accomplished, as the first week showed a slump in output.

Arriving one morning long before seven, he heard that the Old Man had come in on No. 4 during the night and was already somewhere on the premises. Apprehensive of trouble, he hunted up the Old Man and found him wandering through the boiler shop.

After a cheery exchange of greetings, the Old Man said: "Scott, it is as I expected. Brown hasn't a thorough organization here, and while I know you have worked hard it is too great an obstacle to overcome. But while Brown is observing how the other fellow gets results, we will inaugurate the beginning of a new era in the Ashville organization ready for his return. Call a staff meeting after work this afternoon."

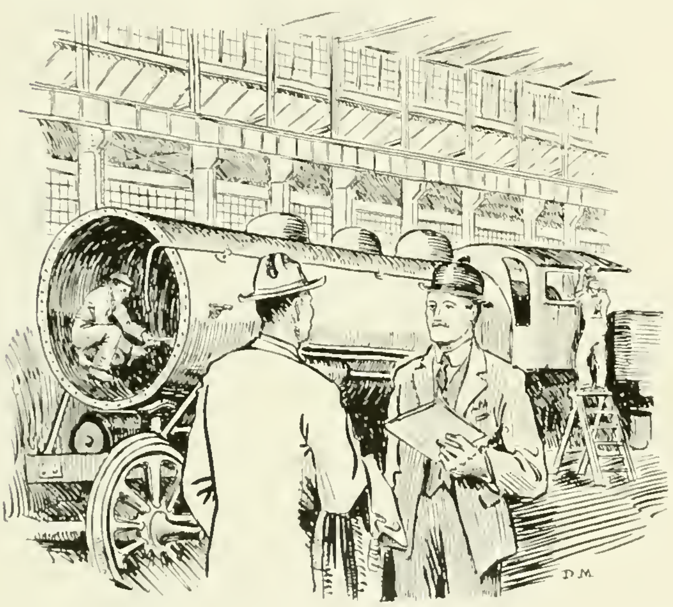
Promptly at four o'clock the foremen gathered in the shop superintendent's office, where the Old Man told them the essentials of organization and the need for understudies. He then told each to select a competent understudy by morning, and he and Scott would complete a temporary reorganization which would be effective until Brown's return. And further, to insure the proper training of understudies, he stated that thereafter each understudy would be required to assume the duties of the man for whom he was to substitute three days each month.

That evening Blount and Scott provided for the morrow, arranging to have Jack Green, machine shop foreman, assume the general foreman's duties; George White, fitting

shop foreman, to take Jack's place, and so on, filling every position with a foreman or a mechanic for understudying. Of course, this did not have an immediate magical effect on restoring shop efficiency, but improved operation was steadily noticeable.

In the meantime Brown at Mountain Dare was beginning to realize the Old Man's motive in sending him away. The Mountain Dare shops were of about the same size as his own and similarly equipped, yet the average output was three to five engines a month greater than at Ashville and the costs lower. Surprised as well that Welsh, the D. & O. shop superintendent, should have so much time to spend with him, he learned that Welsh believed firmly in organization and direction of shop operation with control charts.

Brown learned that instead of blindly hunting for obstacles, Welsh spent hours at his desk carefully studying results from these records, planning his campaigns for improvement from their indications and depending upon the ability and training of his organization to accomplish results.



He Was Surprised that Welsh Had So Much Time to Spend With Him

The days passed swiftly for Brown, and he eagerly went into erecting shop, boiler shop, blacksmith shop and machine shop practices and operations. Unhampered by details of shop operation, free to investigate in any direction, and alert with the new-found consciousness of the rut in which he and Ashville had been traveling, he found the days far too short. Aroused by the developing realization of possibilities for improvement at Ashville, he observed, studied, asked questions during the day, and in the evening, when not joined at the hotel by the shop superintendent or some foreman, spent hours planning applications in his own shop of what he found the other fellow doing.

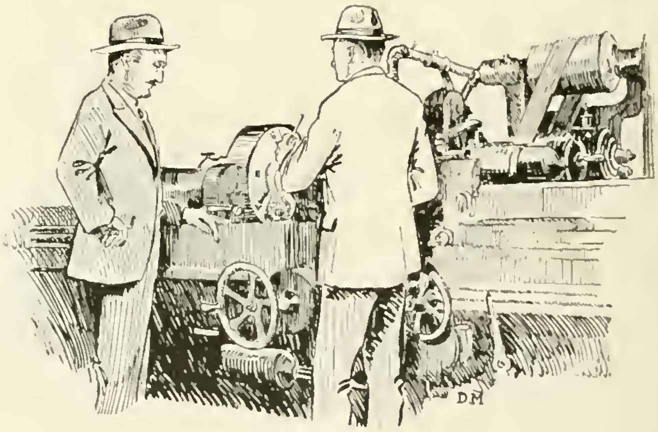
Time slipped by and Brown returned to Ashville, keener from contact with other minds, more dissatisfied with results than before, but fortified by his observations, with valuable suggestions for improvement.

Entering his office the morning of his return, he found the Old Main waiting for him, with his chief clerk. The Old Man greeted him cordially and said, "Tom, I was so anxious to learn of your visit that I decided to run up and talk with you instead of waiting for your written report. But first I want to tell you of the temporary organization we have effected."

"That's right," said Brown after listening to the Old Man, "and that organization will stand. And I am further convinced that when I or the general foreman notice a workman using a wrong practice or doing something that appears wrong we should hunt up the foreman instead of correcting the man. Then if the foreman is wrongly informed he can be set right, without the man learning of his ignorance. At the same time it prevents misunderstandings and needless interference when some deviation from usual practice is required. A shop spirit is built up, increased respect of the workman for his foreman insured, and responsibility absolutely fixed on each man, all of which results in bettering output.

"But I found out that organization not only helps to keep things running smoothly, but it will give me an opportunity to control things if I have the proper records. I am going to have started immediately control charts showing monthly comparisons of man-hours per locomotive repaired and man-hours per 1,000-lb. tractive effort. In addition, in order that I can properly read these figures, I am also going to add a sheet showing the number of heavy operations each month, as for instance, new driving boxes, new cylinders applied, side sheets, fireboxes, flues repaired, etc., and the number of man-hours for the standard unit, so that the approximate effect in man-hours on the month's output by these operations can be readily figured. Then, instead of blindly hunting through the shop for obstacles and points for improvement, I can effectively plan and direct operations from an accurate knowledge of what is going on."

The Old Man was intensely interested to see how Brown had grasped the situation during his three weeks' absence and placed his finger on one of the vital needs for the betterment of Ashville's operation. In fact, he had not only appreciated Blount's view on organization, but he had already indicated how he was going to make the organization work for and serve him.



We Can Use Our Gap Grinder for Crank Pins

Continuing, Brown said: "You remember whenever you tried to get me to install a scheduling system I always replied that I could keep things lined up, and by weekly meetings with the foremen, together with daily contact, we could accomplish all that a schedule system would, and that we didn't need any of these paper systems to run Ashville.

"Well, from now on Ashville is going to have a schedule system. Why, I'd as soon run a ship without a rudder as this shop without a schedule system. The control charts will give me a general hold on the shop, but the schedule system will give me the touch with details that I need. It will show me the weak spots and the delays, so that I can employ my time just where it is needed. It is the man that is falling down, it is the overloaded department that I am concerned with, not the man that is up-to-date. And my daily delay sheet will give me just this information. Then I can investigate the cause and apply the remedy.

"Then another of my stock arguments was that quality of output would be slighted to meet the schedule, big jobs discovered after an engine was shopped would be patched instead of the part renewed if it would result in a fall-down on schedule. The answer to that is a boiler and machinery inspector reporting directly to me and not responsible even to the general foreman. These inspectors will go over the engine not only before it is shopped, but while it is undergoing repairs. Being responsible solely for inspection and familiar with inspection limits, they should be consulted by a foreman before a new part is ordered, instead of repairing the old part. By holding them responsible for quality of output and in no way for quantity, quality will be maintained and where necessary the schedule corrected if something unexpected is found.

"And we're not going to stop with starting an organization, but we're going to wake up in the use of our shop facilities. Aside from some rearrangements required to give better shop movement for material, our big drive is going to be in getting all we can from our machines by using them for what they are best suited, by getting all we can in speed and feed and by using jigs and fixtures.

"The first place we are going to start is with our gap grinder. This is used only for grinding piston rods and valve stems and stands idle over half the time. While larger than needed, we can use it to grind the bearing on all our crank pins, reducing the overtime on our crank pin lathe, due to inability to rough and finish all the pins required. We can also use it, with ample steady rests, for truing up worn air pump piston rods, and if we still have time available, will consider grinding journals of new driving axles. In fact, Ashville expects to begin giving results."

Brown was so deeply interested that more than two hours elapsed while he recited what he had seen and what he expected to accomplish. J. D. Blount listened intently, interrupting only occasionally to ask a question or grunt an assent. As Brown concluded he turned to him and said, "Tom, what I told Shoan was right. It was only organization and methods that were wrong with Ashville. The personnel is here, but it has lacked direction. And you have proved to me that to keep alive we must get in touch with the other fellow."

Then, turning to Shoan, he continued: "Shoan, we will require, as a test of organization and the ability of the executive to put himself into the organization as well as furnishing an opportunity of getting out of a shop rut, that each shop superintendent of the B. & N. E. take two or three weeks each year visiting other shops. Arrange to have Davis of Corning follow Brown's route next week."

The National Agreement with the Shopmen*

Securing Co-operation from the Workmen; Apprentices; Stabilizing Working Conditions

BY FRANK McMANAMY

Manager, Department of Equipment, Division of Liquidation Claims, U. S. Railroad Administration

THE two real difficulties in connection with private operation of railroads immediately prior to the time the railroads were taken over by the government were labor conditions and financial conditions which I have stated I believe in the order of their importance; because the government could at any time relieve the financial conditions, but it could not so readily relieve the labor conditions; and after all railroads or any other industry are operated by men.

It is simply restating an acknowledged fact to say that the labor situation was extremely serious in the latter part of 1917, due to a number of causes. Large numbers of men had been drawn from the railroads for military purposes, making a serious shortage of skilled men in the railroad business. Because of the failure of the railroads themselves during a long period of years to take necessary steps to train mechanics by maintaining a full quota of apprentices, there was no available source of supply and no large number of apprentices which could in an emergency be drawn on to do mechanics' work. There was also a widespread distrust on the part of railroad labor of the motives behind any attempt to increase working hours or in any other way to modify the working agreements which had been obtained by railroad employees after years of negotiation and the expenditure of vast sums of money, as well as by numerous strikes which were disastrous alike to employer and employees. The organizations looked with a suspicion on any request to waive any of the privileges thus gained and feared that the national emergency would be taken advantage of to take away from them some of the privileges which they enjoyed as a result of the efforts of their organizations.

There was no supply of men to draw from to meet this emergency and the situation could only be met by co-operating with labor in a fair and open manner and by obtaining their consent to the temporary waiving of some of the provisions of their agreements. They could never have been accomplished by individual carriers, because there could be no assurance given which would be satisfactory to the employees that once these privileges were given up they would ever be restored. Therefore, it appears to be conclusive that at this period no other agency except the United States Government could have effectually handled the labor situation as it existed at that time.

The first national agreement covering all railroad shopmen is represented by Director General McAdoo's letter of February 14, 1918, to A. O. Wharton, president of the Railway Employees' Department of the American Federation of Labor, in which an understanding with shopmen was reached whereby certain privileges long enjoyed by them and covered by many agreements with railroads were temporarily waived on the assurance of the Railroad Administration that the agreements in full would be restored and observed as soon as the condition of locomotives and cars would justify it; and it is but fair to the representatives of the shopmen to state that when this matter was presented to them an understanding was promptly reached by which they waived privileges obtained through years of negotiation, on the assurance of the Railroad Administration that their agreements would be protected; and that letter constituted the working basis between the Railroad Administration and the shop employees from the day it was issued up to the date of the signing of the national agreement; and from that moment that letter became effective and the working conditions were regulated in accordance therewith, a constant improvement in the condition of motive power and cars became apparent.

Many changes have been brought about by the war, none of which are more far-reaching or important than the changes

*Part of an address before the Western Railway Club, Chicago, March 15, 1920.

in the condition of and the method of dealing with labor, and in my opinion the employer in the future who expects harmony, efficiency and co-operation from his employees must devote at least as much thought to the selection, training and treatment of his employees as he gives to the erection of his shops or factories and the installation of the equipment. In other words, if we are to have a complete, smooth-working, efficient machine, which includes employees as well as machinery, as much time and thought must be given to the study of what might be termed "humanics" in connection with the treatment of employees as we give to the study of mechanics in connection with the erection or operation of the plant.

Suggestions by Workmen

It is a recognized fact that in practically every human activity increased opportunity for a common understanding has been productive of favorable results; therefore, it is difficult to understand just why the average railroad shops is behind industrial establishments in the matter of having a method for obtaining from their employees co-operation and advice relating to shop methods and conditions.

The director general observed and recognized the advantages to be derived from having sympathetic understanding and co-operation between the employees and the officials, and tried to work out and have put in effect a system which would insure a greater degree of co-operation and give to the management the full benefit of the knowledge and experience of the workmen and their suggestions as to improvements in methods to bring about increased efficiency. Several months ago he suggested to the regional directors the advisability of arranging for employees through their regular organizations to select a committee for the purpose of considering with the local officials questions affecting matters relating to shop operation and output.

The plan under which this suggestion was to be carried out was by regular meetings between the local officials and the committee selected from the shopmen to discuss with the utmost frankness all questions involving the planning and the carrying on of the work, inviting suggestions from the committee and endeavoring to give full weight to all of these suggestions that might be meritorious. It, of course, must be clearly understood that these meetings were not to be for the purpose of adjusting grievances, either directly or indirectly, and that such matters must not even be discussed. The following illustrations were given of subjects which were considered as probably suitable for such discussions:

1. Co-operation between departments.
2. Proper storage and care of material.
3. Distribution of material.
4. Tool equipment and distribution of hand tools.
5. Grouping of machine tools.
6. Machine operation and crane service.
7. Scheduling work through shops.
8. Better classification of freight car repairs and whether certain work can be more economically done.
9. Improved methods of making repairs.
10. Method of handling and disposition of scrap.
11. Inspection of scrap and reclamation of usable material.
12. Condition of shops and shop grounds.

The above was not given as a complete list of the subjects which might properly be discussed, but simply as a general outline of matters on which a discussion would no doubt prove beneficial. The plan contemplated one representative from each of the crafts, except in the larger shops where the representation could be increased as might be found desirable. The ranking mechanical department official at the shop in question should preside, all others attending the meeting to be on exactly the same basis so far as the discussion of the matters presented was concerned. In order to have a free discussion it would, of course, be necessary to have the representatives of the employees and the junior officials express their opinions first. Otherwise a free discussion would not be possible, because in some instances men might hesitate to express opinions contrary to those of the ranking officials.

Owing to lack of time this plan was never put into complete operation, but was submitted to the federal managers, and many expressions of approval were received. Similar plans are now in operation in many industrial establishments and have proven to be very beneficial.

Advantages of National Agreement

National agreements cannot be made in all lines of industry, but the transportation industry is essentially a national one. The work of conducting it is substantially the same in Maine and California, in Montana and Texas.

Equipment to a large extent has been standardized, partly by the different associations of railroad officials, partly by law, and partly by the Railroad Administration. Standard transportation rules have been adopted by practically every railroad in the country. The interchange of freight cars is complete. Tickets and bills of lading are practically uniform; and with the consolidation of ticket offices throughout the country, which was adopted by the Railroad Administration, the practices in this respect became almost as nearly standard as in United States post offices. Under such conditions it is not only idle but illogical to think of keeping the man-power which operates the railroads separate and working for different rates of pay on different railroads and under different working conditions.

Among the principal benefits to be derived from the national agreement is the stabilization of shop organizations and the elimination of what had become almost an institution in connection with railroad shop labor; that is, the "boomer" mechanic, who was continually moving from place to place in search of conditions more to his liking. Everyone will admit that the ideal shop organization is a force of what has by the boomer been termed "home guards," who select railroad work shop as their permanent occupation and who wish to establish themselves permanently at the point where they are employed, own their homes, take a part in the general affairs of the community, cultivate a circle of friends, educate their children, and in general enjoy the privileges and exercise the duties which are supposed to fall to the lot of the average American citizen. Under such conditions men become familiar with the work required of them, study the details of the particular equipment which they are required to handle and the peculiar conditions which they are required to meet, take an interest in the general operation of the railroad, and become a part of the permanent organization which is necessary for the successful operation of any property.

A national agreement insuring equal privileges to men at all points on all lines will help to bring about this desirable condition. On the other hand, if we are to have on one railroad certain favorable conditions of employment which do not exist on other railroads it will necessarily cause men on a large number of railroads to be dissatisfied with their working conditions and to constantly, and we may as well say properly, strive for an improvement of their own conditions to compare with those on the neighboring line. This affects efficiency in many ways. It not only results in a constantly changing force of mechanics, which is hurtful, but it is also fatal to that spirit of loyalty to the employer's interest without which no railroad can be efficiently operated.

A national agreement with railroad shopmen brings stability to the railroad organization, and by virtue of the large number of men covered by it acts as an insurance against local disputes in the same way that life insurance or fire insurance protects the individual by distributing the losses over a large number of those participating in it.

It is entirely possible for the individual at a local point to become so dissatisfied with certain working conditions, which are in no way general and which can be readily remedied by a reasonable application of the agreement, that they will go

on strike to remedy conditions which could be much better handled in another way. As a matter of fact, however, such local strikes are not desired by the organizations of the employees any more than they are by the railroads, and while we have, during the period of federal control, had more than 200 of such local strikes, not a single one of them has been sanctioned by the national organizations, and these organizations have always been helpful in restoring normal conditions.

The Apprenticeship Question

One of the conditions which we developed as a result of the national agreement is illustrative of the fact that the arguments which are used by one side or the other to any controversy are often based on the wildest kind of a guess, for the reason that no one has ever developed the facts. I refer to the apprenticeship rules in the national agreement. The employees have for years favored regulating the number of mechanics by regulating the number of apprentices, with the purpose in mind of avoiding an over-supply of mechanics with its resultant effect upon the rates of pay. The employers have opposed this plan of the employees because they believed it was unfairly restricting the number of mechanics which were being trained and was reducing the supply of mechanics to an extent which made successful shop operation difficult.

The ratio which had been agreed to by the employees and the officials on many railroads of five to one was held by the employers to be too low, and it was urged that this ratio would not provide a sufficient supply of mechanics. In negotiating the national agreement we felt justified in accepting the fact that such agreements were satisfactorily meeting conditions on a large percentage of the railroads of the country as evidence that the ratio was reasonable; therefore, the ratio of one apprentice to five mechanics was incorporated in the national agreement.

In order to bring out as nearly as possible just what this would mean, I immediately started in to develop the actual conditions which existed and to see how nearly we were in fact working to the ratio which was set forth as the proper one. A complete check of all the railroads in federal operation showed that we had in service 17,268 apprentices, while under the ratio provided in the national agreement we were entitled to 64,182.

In the Eastern region the ratio of mechanics to apprentices was 21.40; in the Allegheny region, 30.95; in the Pocahontas region, 14.18; in the Southern region, 13.48; in the Central Western region, 12.75; in the Northwestern, 22.44; and in the Southwestern, 11.89, making an average for the country of 18.58 mechanics for each apprentice.

It will thus be seen that the opposition to this rule was due almost entirely to the absence of complete and accurate information concerning existing conditions. We were informed by many railroads that the reason the number of apprentices was so extremely small was because they were unable to obtain more. If that is true it would certainly seem to be illogical to dispute with the employees over the proper ratio and to blame the shortage of mechanics on the restrictions contained in the working agreements. Our investigations, I think, show without doubt that the ratio of apprentices provided for in the national agreement is reasonable and fair, and that it will provide a sufficient number of skilled mechanics if it is consistently followed.

Based on Former Agreements

There is nothing freakish about the present national agreement with shopmen, and it was not, as some have assumed, adopted without the most careful and thorough discussion and consideration. It is based on the agreements which were in effect on a large percentage of the railroads of the country and which had proved to be practicable and workable. It was discussed for approximately four months by a joint committee representing the different regional directors and a committee representing the various national or international shopmen's organizations. The rules which were agreed to at these conferences and those on which no agreement could be reached were then referred to the Board of Railroad Wages and Working Conditions, where both sides presented arguments, and the matter was in the hands of this board for approximately four months. The wage board failing to agree upon the terms of the national agreement, it was then turned over to the mechanical department of the Division of Operation, where, with the assistance of the Division of Labor, the agreement in its present form was negotiated and submitted to the director general, who approved it on September 20, to become effective October 20, 1919.

It is true this agreement does not cover every difference of opinion which may arise between local officials and local committees or between general officials and general committees, and it was not expected to. It does, however, provide a sound basis upon which to handle such differences if it is accepted by both sides with a sympathetic purpose to carry out the very obvious intent of the different rules.

It is true that we have received in the neighborhood of 2,500 requests for information concerning the application of the various rules, which has practically all been furnished. Some of the questions presented are of a character which cannot possibly be covered by any national agreement or by any interpretation of an agreement, but are local matters which can only be handled with a knowledge of local conditions.

Rules 35 and 36 are worthy of special mention because they provide means for settling all grievances which may arise. Rule 36 also contains the following provision for avoiding strikes which were never before contained in a working agreement: "Prior to the assertion of grievances as herein provided, and while questions of grievances are pending, there will neither be a shut down by the employer nor a suspension of work by the employee."

It is not to be expected that this provision will entirely prevent either of the evils it is aimed at any more than the command, "Thou shalt not steal," has made all men honest, but it points the way to a better method of handling disputes and provides a working basis on which to adjust them.

The special rules of each craft which set forth the qualifications of mechanics will provide a better organization than the plan of training specialists who can do but one thing, which perhaps through necessity was followed in many shops, as it is generally admitted that the supply of all-around mechanics was invariably less than the demand.

The agreement properly applied will stabilize working conditions, remove causes for disputes and provide means for settling them, enable you to build up permanent forces, and provide through the apprenticeship system for an adequate supply of mechanics to successfully and efficiently operate railroad shops, and this is all it was intended to do.

Discussion

The discussion of Mr. McManamy's address was something of a disappointment, considering the large attendance at the meeting. Summed up, there seemed to be a feeling that the men were working at a low rate of efficiency and that there was not the incentive that there should be to encourage them to put forth their best efforts. An instance was cited where the man-hours per engine for general repairs had increased from an average of about 6,200 in 1917 to 8,000 in 1919.

Several speakers commented on the difficulties caused by the classification of men of little or no training or ability as full mechanics. All-around mechanics must be developed.

Stabilizing the working conditions should do much to prevent the shifting of men from one road to another, although this has thus far not been entirely eliminated.

The routing or schedule system has helped to offset the loss in efficiency caused by the cutting out of piecework.

The roads generally are not doing what they should in connection with the training of apprentices.

THE METHODS USED IN HEAT TREATING STEEL*

Concise Statement of Salient Points, the Knowledge of Which is Essential for Correct Practice

THE modern practice of the heat treatment of steel has become so complex, involving as it does a very definite knowledge of the thermal changes occurring in the metal as it is heated or cooled, *i. e.*, the critical transformations, the initial microstructure of the metal and the structural changes which may be effected by various treatments, correct methods of heating and cooling, the modifications of practice induced by the introduction of various alloying elements, etc., that even an elementary discussion of the subject becomes involved and complex. Below are listed a few of the salient points in the various fields of the heat treatment of steel, a thorough knowledge of which is absolutely essential for the proper handling of material in these operations.

Steel is essentially an alloy of iron and carbon, disregarding for the moment alloys which are added to impart certain properties. The carbon is present as a definite compound with a certain amount of the iron, *i. e.*, Fe_3C, called cementite; it is the condition of this cementite which governs the physical properties of the steel.

In the stable state, at ordinary temperatures, this cementite is separated (precipitated) from the ferrite, as the iron is called, and can be recognized under the microscope as a separate structural constituent. If the steel is heated, the carbide passes into solution in a certain amount of the iron at a temperature of about 725 deg. Cent. (1327 deg. F.) represented by the line *PK* in the diagram. As the temperature is raised, this solution gradually absorbs the remaining ferrite, until the respective temperature or the line *GOS* is reached, depending on the carbon content, when the whole will be a single solid solution.[1] Steel in such condition preserved down to room temperature would show but one constituent under the microscope. The solid solution which is preserved by very rapid cooling, is much harder at room temperature than the separated condition, which is readily obtained by annealing. Intermediate states are obtained by varying the speed of cooling from the high temperatures and also by slight re-heating of a rapidly cooled specimen. The temperature at which the carbide passes into solution may be detected with a pyrometer, because of the absorption of heat when the change takes place. The temperature range in which this change takes place is called the critical range of the steel.

The great importance of correct methods in heat treating modern steels including alloy and high speed steels makes this article a timely one.

The physical properties of the steel can often be judged from the "grain," which in works' practice is seen in the fracture, and in the laboratory may be seen in the microstructure. In general, coarse grain is taken to indicate weakness and brittleness, while fine grain would indicate strength and toughness. Coarse grain is produced by long heating at high temperatures, and by passing through the critical range slowly in cooling. Fine grain is found in samples heated to but slightly above the critical range and cooled more or less rapidly. Very coarse grain may be reduced by forging, and by cold work followed by annealing.

Any of the various heat treatments applied to a steel may be reduced to a combination of the following elements: (1) heating at a definite temperature for a definite length of time; (2) cooling from this temperature at some desired rate, and (3) re-heating if desired. The more complex treatments consist in the duplication of one or more of these elements together with changes in the various temperatures, rates of cooling, etc. These elements will be considered under the designations—Annealing, Hardening and Tempering.

Annealing

The purpose of annealing steel is: (1) to soften it for machining; (2) to give certain physical properties, *e. g.*, to soften it for some definite service or make it stronger and less brittle by refining the grain, and (3) to remove stresses due to cold-working, quenching, etc.

Temperature—For the purpose of softening or refining the temperatures chosen are usually the same and may be found in the shaded area of the diagram. It will be seen that they vary with the carbon content of the steel; they are further modified, sometimes to a marked degree, by alloys present. For softening in machining it is not absolutely necessary to heat above the critical range.

For removing stresses there is in the case of cold-worked material a fairly definite temperature at which the effects of cold work are removed. This usually lies between 500 deg. and 575 deg. C (932 deg. and 1067 deg. F.); that is, somewhere in that range re-crystallization takes place and the elongated grains divide and become equi-axed. Re-heating after quenching will be considered under Tempering.

Rate of Heating—The size and the shape of the piece must be considered, it being especially important in large and irregular pieces not to force the heating, as the outside of the article and thin parts would be greatly overheated. Pieces should be arranged in the furnace to insure as even heating as possible, and in gas furnaces should be set on supports to allow free passage of the gases underneath the piece.

Rate of Cooling—This is determined, in the case of annealing above the critical range, by the properties desired, by the size of the piece and by the carbon content. For maximum softness the piece is allowed to cool in the furnace. Very large pieces may be removed from the furnace and cooled in the air, their size preventing too rapid cooling. On the other hand, thin pieces of high carbon content cool rapidly enough in air to become quite hard.

"Normalizing" may be considered under the head of annealing. It consists in heating the steel above the critical range and cooling in air and serves to put the steel in an unstressed condition of good crystal size and arrangement. It also minimizes the danger of quenching cracks in high-carbon steels, especially on repeated hardening.

Double Annealing—This is done for the purpose of maximum grain refining. It consists of heating to a temperature somewhat above the critical range, then air cooling or quenching, followed by reheating to a temperature just below the critical range.

Divorce Annealing—Annealing to spheroidize the cementite. Long heating at just below the critical temperature converts the carbide from plate form to granular form; it makes steel especially tough.

Protection During Heating—This may be effected by using neutral or reducing ("hazy") flames when burning gas or

*From Letter Circular VIII-2, compiled and issued by the Bureau of Standards, Department of Commerce, Washington, D. C.

[1]This discussion refers to steels of less than 0.9 per cent carbon. Above that percentage, the excess constituent is cementite instead of ferrite. Hence the range *PS* to *GS* represents absorption of ferrite; the range *SK* to *SE* represents absorption of cementite. At 0.9 per cent all the dissolving occurs at once.

oil, by heating in lime or carbon, and by the use of annealing boxes.

Overheating—Too high annealing temperature; too long heating (size of piece must be considered). "Burning" of steel results from heating to the region of incipient fusion. Overheated steel can be restored by suitable heat treatment, especially in connection with forging. Burnt steel cannot be restored.

Hardening

Temperature—The temperature must be above the critical range; the piece should be heated long enough to insure complete solution (special precautions for alloy steels); too high temperature must be avoided. The annealing range shown in the diagram may be taken as a guide for quenching temperatures. The higher the carbon, the greater the precautions

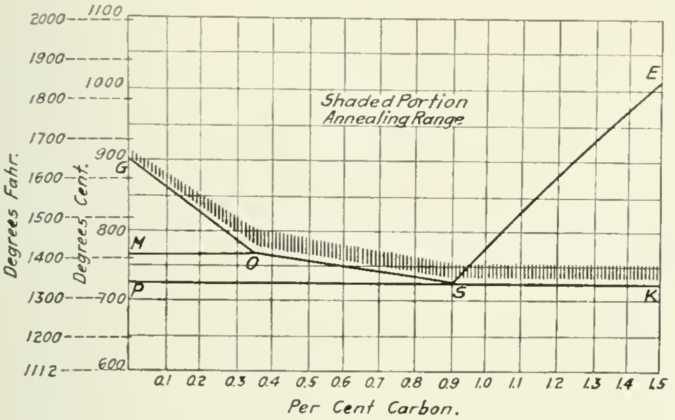


Diagram Showing Critical Temperature Ranges for Steels of Various Carbon Content

to keep the quenching temperature but little above the critical range. In steels having more than one per cent carbon, normalizing from above the upper critical range (line *SE*) may precede quenching, if excess carbide is in plate form which would weaken the steel.

Method of Heating—This may be: (1) Open furnace; precautions same as in annealing; or (2) baths of molten lead, barium chloride, sodium chloride, etc. The latter has the advantage of accurate temperature control, uniform heating, no danger of overheating. Salt baths give clean steel on quenching, but decarburize the surface with long heating.

Quenching—Different liquids have different speeds of cooling and so impart different degrees of hardness to steel on quenching. The following represents an average of the data from many different sources, and indicates roughly the relative hardening that may be expected:

Quenching medium	Time of cooling specimen from 800 deg. C. to 250 deg. C. (1472 deg. F. to 482 deg. F.)
Water at 20 deg. C. (68 deg. F.)	1.0
Water at 50 deg. C. (122 deg. F.)	1.2
Water at 80 deg. C. (176 deg. F.)	1.4
Water at 100 deg. C. (212 deg. F.)	3.0
Brine at 20 deg. C. (68 deg. F.)	1.0
Brine at 60 deg. C. (140 deg. F.)	1.0
Brine at 80 deg. C. (176 deg. F.)	1.2
Alcohol 20 deg. C. (68 deg. F.)	1.0
Corn oil 20-75 deg. C. (68-167 deg. F.)	1.3
Fish oil	1.5 to 1.9
Lard oil	1.6 to 1.8
Sperm oil	1.7
Linseed oil	1.8
Cottonseed oil	1.9
Mineral oils at 20 deg. C. (68 deg. F.)	1.3 to 2.5
Mercury at 20 deg. C. (68 deg. F.)	2.5
Glycerine at 20 deg. C. (68 deg. F.)	3.0
Air at 20 deg. C. (68 deg. F.)	15.

The quenching power of cooling baths decreases as the temperature rises, but oil changes very little. Salt solutions do not change as much as water. Cooling coils may be used for cooling the bath. The amount of quenching liquid should be sufficient in relation to the size of piece to prevent an undue rise of temperature of the bath. Stirring the bath and moving the piece causes it to come in contact with cool liquid.

To prevent warping, thin pieces should be quenched axially, should not have excessive scale, and should be normalized after cold-working before quenching.

Tempering

Purpose—Tempering relieves stresses due to quenching, reduces brittleness, especially in water-quenched pieces, and toughens the steel. It produces elasticity for springs.

Temperatures—Tempering may be done at any temperature below the critical range, but usually between 100 deg. and 500 deg. C. (212 deg. and 932 deg. F.), depending on the use to which the material is to be put. The range for various purposes is as follows: 100 deg.-150 deg. C. (212-302 deg. F.), razors and other hard cutters (brittleness not objectionable); 200 deg.-300 deg. C. (392 deg.-572 deg. F.), cutting tools (chisels, milling cutters, knives, etc.); 300 deg.-400 deg. C. (572 deg.-752 deg. F.), springs (high elasticity); above 400 deg. C. (752 deg. F.), great toughness and resistance to shock.

Regulation of Tempering—Longer heating causes greater softening. Long heating at low temperatures is better than short heating at high temperatures; it gives greater uniformity. The rate of cooling has little influence on the results, as there is no transformation. Pieces are often quenched for convenience. The temper color is due to the formation of a thin surface layer of oxide, and is a true indication of the degree of softness at the surface when there is free access of air. Longer heating at the same temperature gives a darker color.

Tempering baths of oil, fused salts or fused metals offer the advantages of accurate temperature control and uniformity.

"Blazing off," *i. e.*, heating to the flash point of the oil after oil quenching, is undesirable as it results in uneven heating with excessive heat at the surface. Large pieces may be tempered by removal from the quenching bath while they are still hot enough to temper of themselves, but exact regulation is difficult.

Case Hardening

The purpose of case hardening is generally to impart a very hard wearing surface with a softer and more resilient interior for withstanding shock, as in cams, gears, etc. The composition of the base steel is usually about 0.2 per cent carbon; some alloys are advantageous, especially a small amount of chromium.

Carburizing—The article is heated for a suitable length of time in solids or molten baths. Solids used for this purpose are mixtures of charcoal, charred leather, bone, etc., with barium carbonate or other carbonates. The time required is from five to 20 hours at 875 deg.-950 deg. C. (1607 deg.-1742 deg. F.). A deep case is produced.

Liquids used for carburizing are molten potassium cyanide, sometimes mixed with chlorides, other cyanides, etc. From one to 15 minutes at temperatures from 800 deg.-900 deg. C. (1472 deg.-1652 deg. F.) are required and a thin case is produced. These liquids are highly poisonous.

In "pack hardening" the pieces are heated just above critical range (750 deg. C. or 1382 deg. F.) while packed in solid cements, for about two hours, after which they are quenched in oil. This process is used only on high-carbon steels.

Portions of pieces to be left uncarburized may be protected by plating with copper, etc.

Heat Treatment—The aim is to produce a hard case, with an interior refined of the effects of overheating and rendered capable of resisting shock. After carburizing with solids, double quench the pieces, first from above the critical range of the core to refine the grain of the core after the long heat-

ing, and then from just above the critical range of the case, to harden the case properly.

When liquid carburizing agents are used the carburizing bath is usually kept at the hardening temperature and the piece quenched directly.

The pieces may be tempered as desired.

Alloy Steels

Though the heat treatment of such steels is, in principle, essentially like that of the plain carbon steels, the introduction of the alloying element, *i. e.*, nickel, chromium, tungsten, etc., modifies the practice so profoundly that each type requires a special study.

In general, the addition of the special element may modify the treatment and therefore the properties in the following ways:

(*a*)—By the lowering of the critical ranges or transformation temperatures, forms which in plain carbon steels are stable only at high temperatures may become the stable forms even upon slow cooling. Nickel is one illustration of this behavior.

(*b*)—The critical changes may be made to take place much more slowly than in carbon steels of the same carbon content so that the transformation temperature is raised upon heating and lowered upon cooling. Chromium illustrates this behavior. In general, the alloy steels are much slower in their response to heating than are the plain carbon steels, thereby permitting a longer heating period of a higher temperature without exposing the steel to the danger of becoming so coarse as would be the case if the special element were not present.

(*c*)—The structural condition in which the special element exists determines largely the properties of the steel and to a large extent the heat treatment necessary to develop the required properties, *i. e.*, whether the added element enters into the ferrite constituent (nickel is a case of this), or into combination with the carbon (as with chromium and tungsten). The double carbide formed in the latter cases increases the mineral hardness of the steel without increasing the brittleness to such a degree as an addition of an equivalent amount of carbon would do.

(*d*)—By the addition of two or more special elements, the advantages of each may be retained and the disadvantages largely neutralized, as in chromo-nickel steels which, as a type, probably represent the best all-around alloy steels in commercial use for general purposes.

Reference to some of the books on the subject of special steels must be had for definite information upon the special alloy steels, their heat treatment, characteristic properties, and special uses for which each is adapted. Most of the steel companies manufacturing special grades of steel have worked out, experimentally, the heat treatment necessary to bring out the most desirable physical properties of their particular steel; upon purchasing, directions are given concerning the heat treatment.

High Speed Steel

The introduction of large amounts of alloying elements in high speed steels caused radical changes in the nature of the steel. The heat treatment therefore differs greatly from that usually applied to steels. Hardening is effected in principle as before by bringing the carbides into solution in the iron and cooling at such a rate as will leave them in solution. The presence of large amounts of tungsten and chromium changes both the temperature required for affecting the solution and the allowable range of cooling rates.

Annealing—This is effected by heating at 850 deg. C.-900 deg. C. (1562 F.-1652 deg. F.) for periods sometimes as long as five hours, depending on the nature of the steel.

Hardening—The steel is heated very slowly to about 700 deg. C. (1292 deg. F.) then very rapidly to about 1200 deg. C. (2192 deg. F.) and cooled in any way desired,—air, air-blast, oil or water. The rate of cooling has no great influence on the hardness, as the carbides remain in solution except on extremely slow cooling.

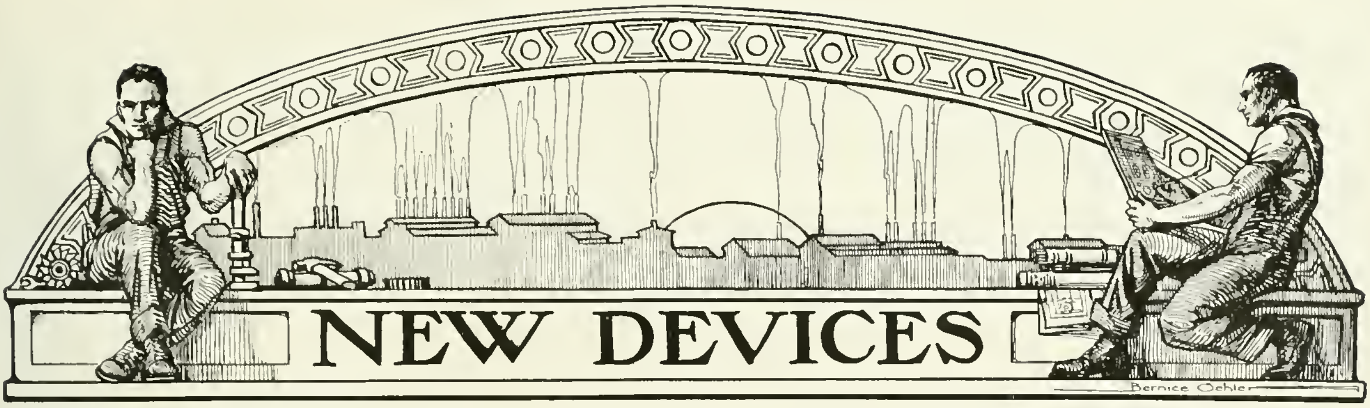
Tempering—High speed tools are generally not tempered, although tempering at 500 deg.-600 deg. C. (932 deg.-1112 deg. F.) is recommended for some tools. After water-quenching, it may be advisable to remove cooling stresses by tempering at a low temperature.

Special Alloys—Certain alloys, not properly steels, have come into use as high speed cutters. "Stellite," a cobalt-chromium-tungsten alloy, requires no heat treatment and responds to none. It is cast to shape and ground. Other unusual combinations of chromium, nickel, zirconium, molybdenum, etc., have been used, the nature of the alloy determining whether it requires heat treatment and in most cases such treatment is not required.

Locomotive Used as a Shell Press.—The proceedings of the Societe des Ingenieurs Civils de France contain the account of an ingenious device for drawing down 75-mm. steel shells during the war. Like all other works in France, the Bordeaux shops of the South of France Railway Company were called upon at the outbreak of war to contribute material for the defense of the nation. In view of the urgent demand for larger quantities of 75-mm. shells they adapted a portion of their machinery to the making of these, starting from steel bars cut to length. These were upset hot in a die and the piece was then given a cup shape by means of a punch and die system. It was then necessary to draw down the piece to a cylindrical shape, requiring a pressure of from 80 to 100 tons, and for this the Bordeaux works of the Midi railway had no machine available. Considering the time it would have taken to build, or to await the delivery of a hydraulic press for the purpose, they looked around for temporary means of increasing the shell supply. A trial was made with a powerful locomotive built for service on heavy gradients, one of which happened to be lying idle pending repairs.

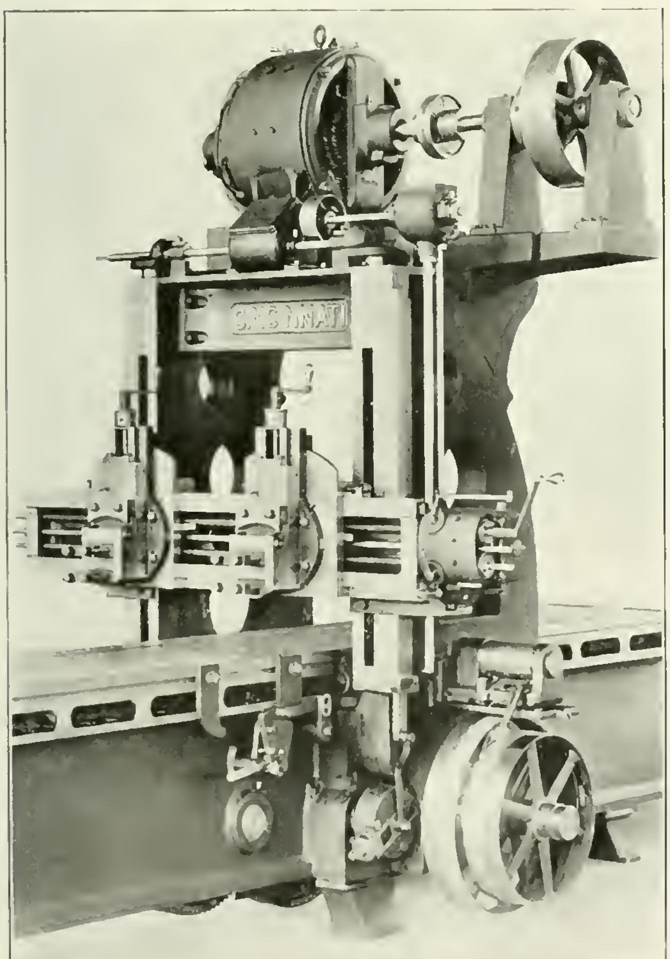
The locomotive was moved to a position in front of a stout wall on which the drawing room die holder was supported. It was then raised so that the wheels were clear of the rails and a punch was fitted to the tail rod of one of the pistons. A cup was then heated to a red heat and placed in the die, when the opening of the regulator valve drove the punch forward and caused the cup to pass through the die. The test being successful, it only remained necessary to make the installation more convenient for use. It was operated successfully for about two years and produced several hundred thousands of 75-mm. shells, pending the putting down of a more suitable hydraulic plant. It enabled the works, from the very commencement of the war, to do away with the manufacture of shells by boring out of the solid, thus saving a large quantity of metal and much time.—*Engineering, London.*

Operating Methods and Fuel Economy.—If you would get out and get the slow orders off your railroad, and get trains made up so that every train doesn't have to stop and set out something at every cross road; if you would see that your despatchers know what is going on and make them take the responsibility which is justly chargeable to them, the engineers and firemen would be relieved of a big load that they have been carrying for years and your fuel bill and other operating expenses would be reduced more than can ever be accomplished by further education of the engine crew.—*H. C. Woodbridge at the Central Railway Club.*



GENERAL PURPOSE PLANER

While there has been little change in the general appearance and operation of planing machines for many years, several improvements have been embodied in the later models to make them more efficient and capable of higher production. Among the improvements embodied in the line of planers manufactured by the Cincinnati Planer Company, Cincinnati, Ohio, may be mentioned the use of herringbone



Cincinnati Planer Provided With Latest Improvements

gears in the first reduction of the table drive, forced lubrication, quick power traverse of the heads, and the box type bed. These improvements make the planers of particular interest to machine tool users.

The planer bed is designed for maximum rigidity and is of a box type construction, which not only prevents the accumulation of chips, but also safeguards the operator against catching an arm or leg between the table and the usual open bed crossties. The walls of the bed are securely tied together by heavy T-shaped girths.

Forced feed lubrication is provided by means of an oil pump positively driven from the main drive shaft. The oil is thus circulated from a reservoir under pressure to both vees at a central point. It is then distributed outward to the return pockets at the ends of the bed, whence it is returned to the reservoir by means of suitable pipes. A special form of oil grooving provided on the table vees insures complete lubrication even when the planer is operating on short work.

The advantage of herringbone gears in the initial reduction of the table drive lies in the smoother motion imparted to the table. The use of herringbone gears, together with the rigid construction of the machine throughout, eliminates chatter and tool marks on the work. Perhaps the one feature which adds to the high production capacity of the planer more than anything else is the rapid traverse of the heads, operated by control levers conveniently located. Power traverse of the rail heads is provided on all sizes of Cincinnati planers from 30 in. to the 72 in. standard. On sizes larger than 72 in., power traverse is provided on all four heads. The mechanism is foolproof, since the feed and rapid traverse cannot be engaged at the same time, and a safety device is provided against breakage, should the heads accidentally come together. Power traverse of the heads eliminates hand operation and results in a material saving in time and increases the machine output.

FEEDWATER PURIFIED BY EVAPORATION

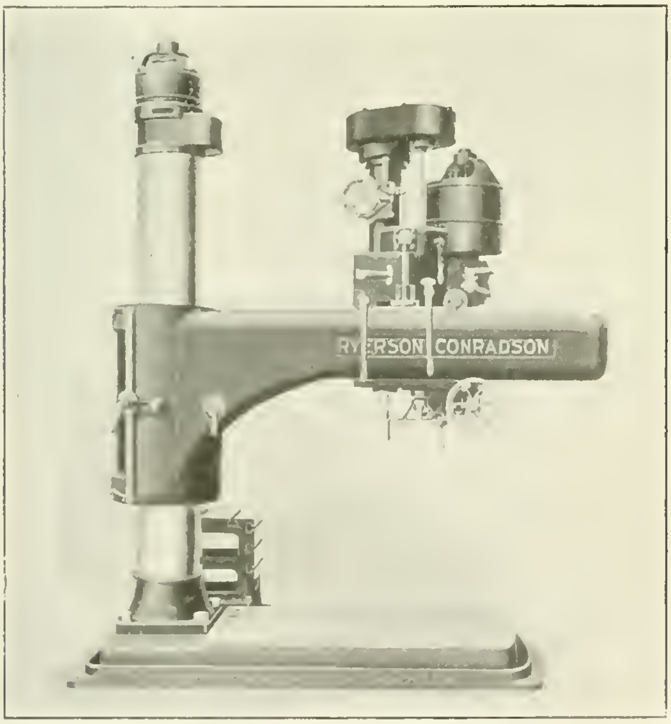
One of the serious problems of many railroads is to provide some means of softening the feedwater, or in other words, purifying it, to prevent the formation of boiler scale or foaming of the water. One method of purifying water, familiar to every one, is by evaporation, and the application of this method in the marine field has extended over more than 50 years. It was not applied to any extent in stationary power plant practice, however, until about five years ago. It has been claimed that the great advances in power plant efficiency were fostered and first brought out in marine practice, because operation on board ship demands high grade equipment, minimum shutdowns and the greatest ease of repair. As an example of the above statement may be mentioned the purification of boiler feedwater in both large and medium central station plants by means of evaporation. This practice has now been carried on for at least five years, and a special form of device, known as the Reilly evaporator, has been developed by the Griscom-Russell Company, New York.

The purification of boiler feedwater by means of the Reilly evaporator is accomplished in a similar manner to the estab-

lished shipboard procedure, with the exception that the refinements of operation are even greater. The plants are so arranged that practically all of the heat used in the evaporation of the water by the use of steam is returned to the system. In the actual operation, high pressure steam is supplied to the coils of the evaporator and in condensing in these coils, evaporates the body of water in the shell surrounding the coils. This purified vapor is in turn condensed in a condenser and is ready for boiler feed. This is descriptive only of the basic feature of the plant, and it is the utilization of the hot well water as the condensing water, which makes the system not only a valuable means of purification, but an economical practice as well. The main advantage resulting from the use of the Reilly evaporator is the pure feedwater provided, which eliminates scale in the boiler tubes and the necessity of blowing down the boilers.

TWIN MOTOR DRIVEN RADIAL DRILL

A high power plain radial drilling machine which differs radically from the usual design in many respects, has been placed on the market by Joseph T. Ryerson & Son, Chicago, Ill. The machine is designed for heavy duty, and drilling, tapping, boring and reaming operations can be performed with equal efficiency. An attempt has been made to secure the maximum simplicity consistent with the usual range of work performed on radial drills, and only four shafts and 16 gears are used in the machine. The spindle and driving shafts are all contained in a single cast box of rigid construction.



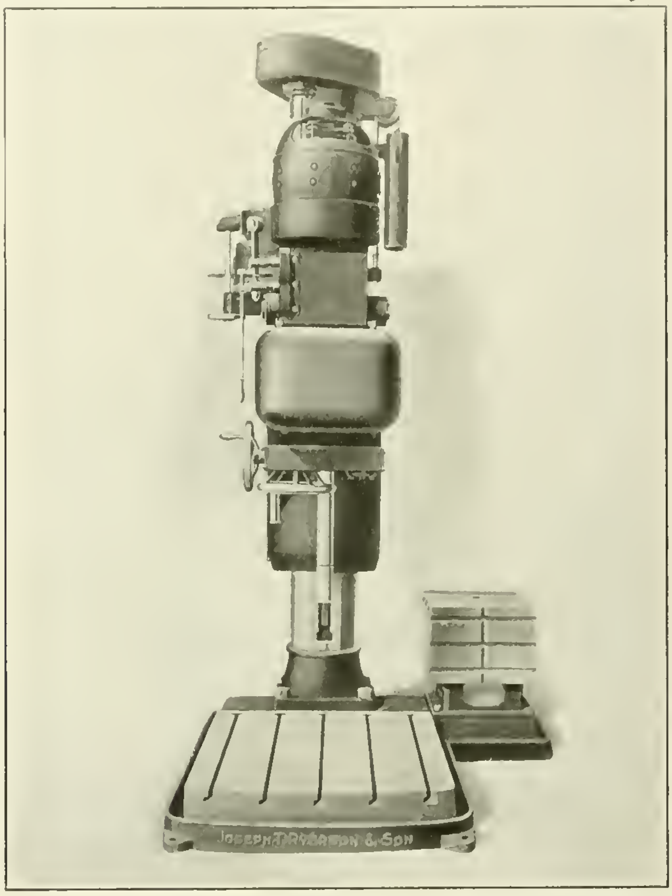
Simplicity in Radial Drill Design Is Secured by Twin Motor Drive

Spur gears only are employed, which eliminates bevel gears and the consequent difficulty of keeping them alined.

The head, mounted on SKF ball bearings, travels on the top surface of the arm and is held in alinement with the arm by parallel vees on its under side. Torsional strains are thus largely eliminated. Due to the absence of power transmitting shafts, bevel gears, friction clutches, etc., the drill is unusually quiet in operation. The cross traverse of the head is facilitated by its being carried on ball bearing rollers, adjustable for wear.

A reversing motor is mounted on the head and directly connected to the drive shaft by means of a self-alined, internally splined coupling. This drive shaft carries a pinion and gear, the pinion being cut integral in the shaft and both run in mesh at all times. The clutch gears are of the conical friction type. The friction cones are mounted on a spacing rod and a movement up or down from the neutral position engages the high or low speed clutch gear. Four other gears are keyed to the clutch shaft and drive the spindle sleeve over change gears on an auxiliary shaft. By shifting the levers, all of which are on the head, the operator engages the desired speed. Sixteen spindle speeds, ranging from 19 to 310 r.p.m. in practically geometrical progression, are obtained in this manner.

For tapping, the motor is reversed, which is instantaneous,



View Showing the Absence of Overhanging Parts and Spindle Travel on a True Radial Line.

and eliminates all shock in the transmission, as well as wear and tear caused by the standard type of friction clutch. The head is completely enclosed and all gears run in oil, a gage indicating the level to the operator.

Feed changes are secured by a cone of gears in connection with a drive key, controlled by a feed-indicating dial and also by engaging in the upper or lower positions a clutch controlled by a lever on the hand-wheel. Two series of eight feeds each, ranging from .005 to .0078 in. and from .0023 to .00370 in. per revolution in practically geometrical progression, are provided. All feeds are disengaged instantly by a friction clutch on the handwheel shaft.

For raising and lowering of the arm, an independent motor of the elevator type is mounted on top of the column. A pinion, keyed directly to the armature shaft, drives a reducing gear on the elevating screw, the thrust of which is taken up by a ball bearing. This composes the entire elevating mechanism and is a very simple arrangement. Limit switches are provided and insure safety. They are equipped with a bracket carrying a roller, which opens the circuit when struck by the sleeve of the arm.

The arm is of box type section, heavily reinforced, and sagging is reduced to a minimum. The center of the spindle is arranged to travel on a radial line, passing through the center of the column. This is stated to be an exclusive feature of the Ryerson-Conradson machine. The arm revolves on ball bearings and means are provided to clamp it securely, a pneumatic clamping device being provided, if desired. The column is provided with an internal web in the line of strain, which greatly increases its rigidity. The base of the machine is surrounded by a deep flange, which materially stiffens it and serves as an oil retainer.

The machine is made in 4-ft., 5-ft. and 6-ft. sizes, drilling to the centers of 8-ft. 1-in., 10-ft. 1-in. and 12-ft. 2-in. circles. To sum up, the advantages claimed for this new radial drill may be stated as simplicity due to twin motor drive, concentration of all shafts in the head, elimination of bevel gears and friction clutches for tapping, exceptional feed range, a spindle operating on a true radial line with the column, and a resulting low power consumption.

JOURNAL COOLING COMPOUND

If it was possible to obtain accurate figures of the direct and indirect costs of cutting out freight cars in this country on account of hot boxes, the total figure would probably be surprisingly large. Some railroads make a direct charge of three dollars each time a car is cut out on account of a hot bearing. Added to this there is indirectly the loss due to

Cleaning Out a Hot Box Preparatory to the Application of Mohawk Cooling Compound

delaying other freight cars, and in case the car cut out is loaded with perishable freight the railroad may be liable for damages.

The estimated cost of removing and reapplying a pair of freight car wheels is six dollars, which together with the cost of machining of $1.20, makes a total labor cost of $7.20 on account of each hot box. The total labor cost, plus the charge of three dollars for cutting out, gives a grand total of $10.20, which may be estimated as the direct cost of a hot bearing. .

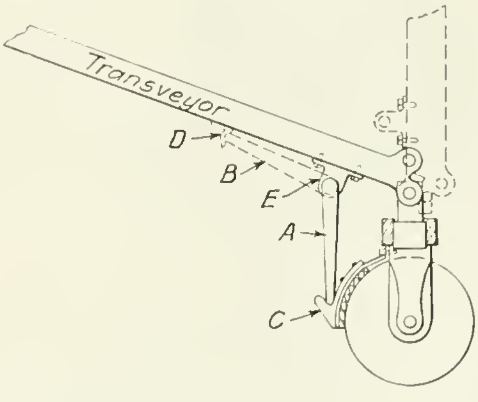
While it is not maintained that a journal cooling compound can prevent all of the hot boxes and their attendant costs, there is no doubt that if each freight train caboose is provided with a supply of suitable compound, which is used as soon as a bearing shows signs of becoming hot, many hot boxes can be prevented and boxes which do run hot will not necessitate cutting out the car.

A cooling compound in the form of soft grease, which combines the qualities of a lubricant and a cooling compound, has been developed by the Mohawk Lubricating Company, Cincinnati, Ohio, and has worked out so well in practice that several of the roads testing it have arranged for a suitable supply to be carried in each caboose. The illustration shows a typical hot box from which the flaming waste and oil is being removed, preparatory to an application of the above-mentioned cooling compound. The method of application is simply to refill the box with clean waste, placing a liberal supply of compound between the waste and the journal. When placed in contact with a hot journal this compound effervesces, expands, and spreads until it reaches the dry spot on a journal. This lubricates the journal and removes the cause of the heat. Under heavy loads and high speeds, hot boxes are more or less inevitable, but when this cooling compound is applied in time, the hot box is cooled as well as lubricated and there is no delay of the train.

It is stated that the Mohawk cooling compound is not affected by climatic conditions such as heat or cold, a test at 40 deg. below zero proving that the compound will not readily freeze. This is a valuable property, as every one knows who is familiar with the difficulty of starting heavy freight trains in the winter time, due to congealed oil and waste. The compound is stated to be free of acids or any other ingredients that would injure any metal or the employee's hands.

TRANSVEYOR BRAKE ATTACHMENT

A brake attachment has been devised by the Cowan Truck Company, Holyoke, Mass., for use with its transveyor lift truck. The new brake is used to ease heavy loads down inclines and will be found to reduce the manual labor involved, and eliminate the danger of damage to freight caused by the truck getting out of control of its operator. The transveyor lift truck is of the three-wheel type, and the brake attachment illustrated is applied to the single forward wheel. Referring to the illustration, *A* is a pendant swinging from



Brake Arrangement on Cowan Transveyor

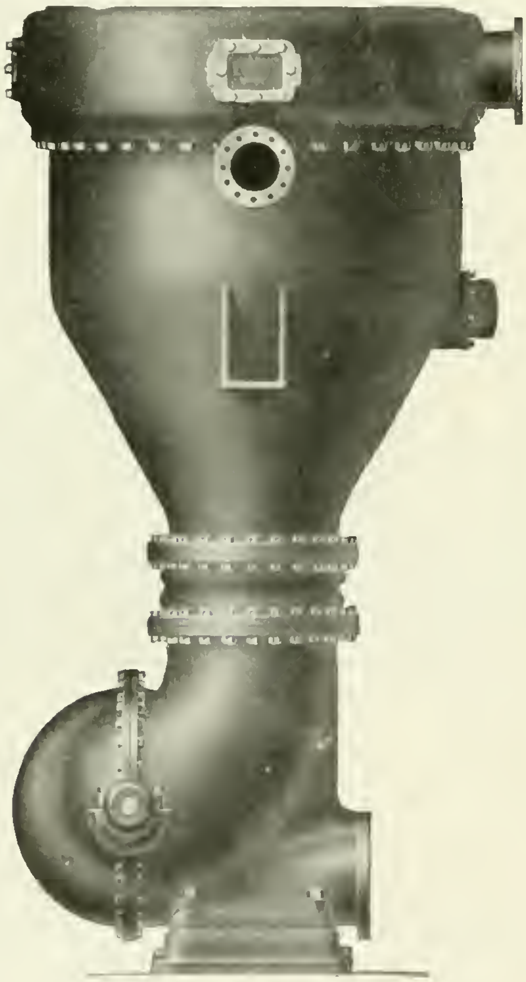
the bracket *E* on the transveyor handle. When it is desired to apply the brake, the pendant *A* is allowed to engage in the casting *C*, which is fastened to a strip of spring steel provided with a brake lining on its under side. The greater the pressure brought to bear on the handle, the greater is the braking effect. When it is not desired to use the brake,

the pendant *A* is swung up out of the way, as shown in the dotted position *B*, and is held to the handle by the spring clip *D*. The brake interferes in no way with the ordinary operation of the truck.

NEW DEVELOPMENTS IN THE WHEELER JET CONDENSER

The latest design of vertical jet condenser manufactured by the Wheeler Condenser & Engineering Company, Carteret, N. J., is provided with a vertically split tail pump casing to facilitate repairs. This feature permits easy and quick removal of the pump rotor or other internal part for inspection. It is simply necessary to remove the bolts and cover and uncouple the rotor. Before this design was developed, considerable time was required to get at and remove the rotor.

Temperature fluctuation in the Wheeler condenser is taken care of by the expansion joint between the pump and the condenser body. In some installations the expansion joint is not recommended, hence condensers are made with or without the joint, depending upon the conditions in the plant. The advantage of this form of jet condenser lies in the fact that it utilizes the heat-absorbing capacity of the cooling water to a great degree, discharging it from the bottom of the condenser at practically the same temperature as the steam. At the same time, the outgoing non-condensible gases come into contact with the water entering at the top of the shell, and are therefore cooled to a low temperature.



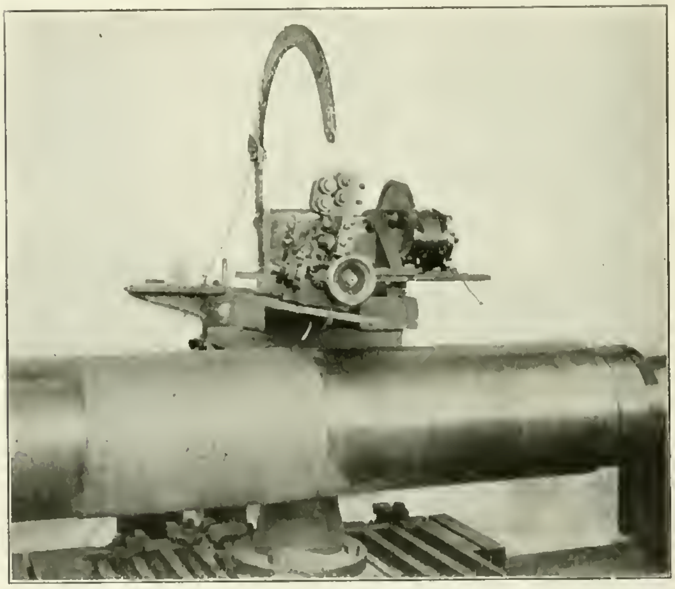
Jet Condenser With Split Tail Pump Casing

In operation, referring to the illustration, steam and water enter at the top. The water is discharged in streams through spiral nozzles, which break up the water current into a rain or spray to insure the desired steam-condensing capacity. The condensed steam and water fall to the bottom of the condenser, where they are removed by the submerged centrifugal pump. The air is removed through an opening just below the cone of the condenser, a small amount of cold water being allowed to fall just in front of the air outlet, thus cooling these gases to their smallest volume. In connection with these condensers, a turbo-air pump or a three-stage steam jet air pump is usually recommended.

AUTOMATIC ARC WELDING MACHINE

Automatic arc welding is accomplished by a device, recently placed on the market by the General Electric Company, Schenectady, N. Y. The welder is for use with the regular welding set, and is designed to take the place of a hand controlled electrode. It consists of a pair of rollers called feed rolls, driven by a small direct current motor, which draw in and deliver to the arc a steady supply of wire, maintaining automatically the best working distance. The machine is controlled from a small panel.

The welding head is held by a suitable support with a certain amount of hand-regulated adjustments and consists of a steel body, carrying feed rolls and straightening rolls, both of which are adjustable for various sizes of wire. The arm is supported on a gear box, together with the motor. This box contains gears which give three gear ratios, thus extending the range of the device while allowing the motor to operate at its most favorable speed.



Increasing the Diameter of a 14-In. Shaft 3/8 In.

The control panel carries an ammeter and voltmeter for the welding circuit as well as rheostats, a control relay, and the contactors and switches for the feed motor. It is possible to start and stop the equipment from the work by a pendent push button, but adjustment of the speed conditions must be made from the panel.

The adjustment for arc conditions by regulation of the speed of the feed motor as the arc voltage varies is taken care of by the panel equipment. The result is a steady arc and more uniform and faster work than is possible with a hand-controlled arc.

The whole apparatus is mounted on a base which can be bolted to any form of support. Thus a great variety of working conditions can be met. Provision must be made

for carrying the arc at uniform speed along the weld. For straight seams a lathe or planer bed may be used, and for circular ones a lathe or boring mill, local conditions, of course, dictating the methods to be followed.

The device should be especially valuable where a large amount of routine welding is to be done, as it is claimed that it will operate with from two to six times the speed which can be obtained by skilled welding operators. It is adaptable to welding seams of tanks and plates, rebuilding worn shafts, journals or wheel flanges.

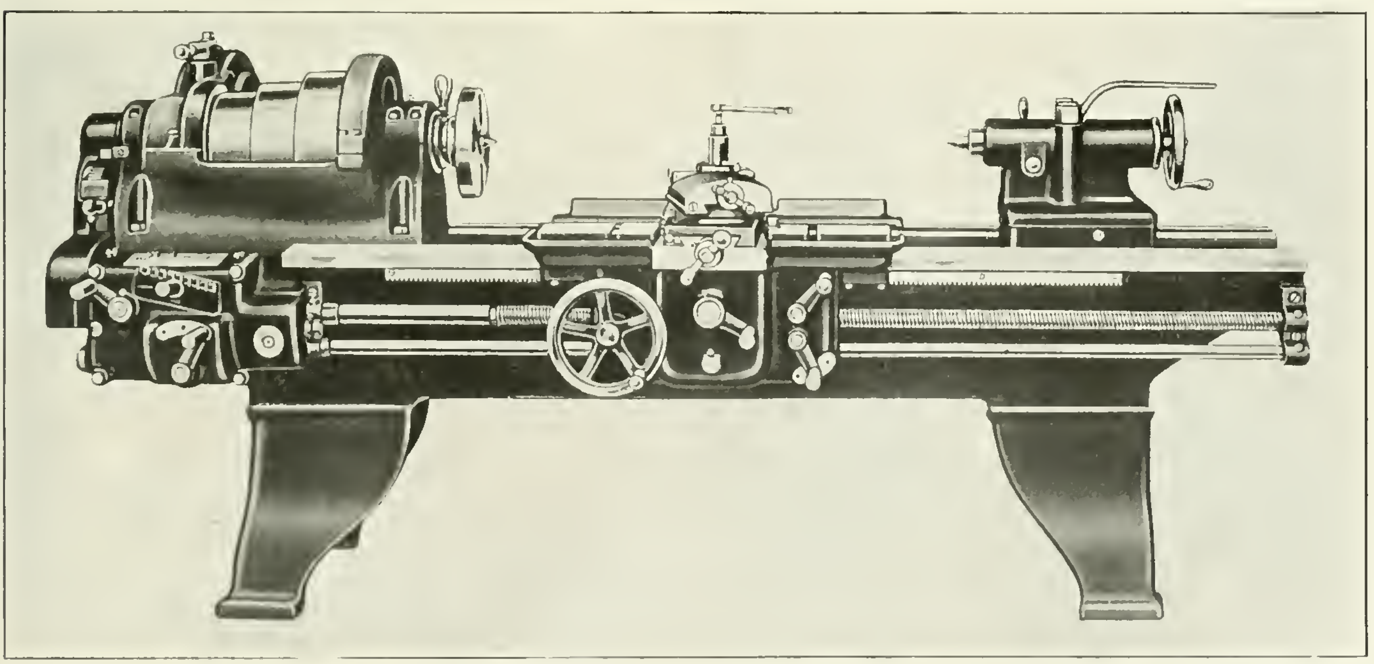
TWENTY-TWO INCH MORRIS ENGINE LATHE

A new 22-in. lathe, provided with a semi-enclosed headstock and quick change feed box, has been placed on the market by the Morris Machine Tool Company, Cincinnati, Ohio. By means of a patented feed box 45 changes of feed are obtainable, and if desired a semi-quick change feed box may be furnished which provides four positive changes of feed. The quick change and semi-quick change boxes are interchangeable, and provision is made for the use of change gears to cut special pitches or metric threads. A chasing dial also is furnished as standard equipment.

Particular attention has been paid to the design of the carriage, which is of heavy construction, especially in the bridge. The carriage is unusually long and is scraped to a bearing its entire length on the bed. The back of the carriage travels on a flat surface and is held down by a flat gib. The front slides on a large vee and also is gibbed to the bed. The apron is a one-piece box casting, in which all bearings are cast integral. All gears are steel and have bearings at both ends of the shafts. Both feed frictions are operated by a single lever, which is stationary. This overcomes the objection of revolving knurls, or star handles, and permits using the power feed close up to the shoulders. An interlocking arrangement makes it impossible to engage the thread and the feed mechanism at the same time. The rack pinion is heat treated and hardened.

The compound rest regularly furnished with the lathe is provided with a swivel graduated in degrees and clamped by a single bolt through a dovetail clamping ring. A taper attachment can be furnished, which has proved satisfactory under severe cuts. It is graduated in degrees and taper per foot. The maximum taper per foot is 4 in., and 25 in. can be turned at one setting of the attachment.

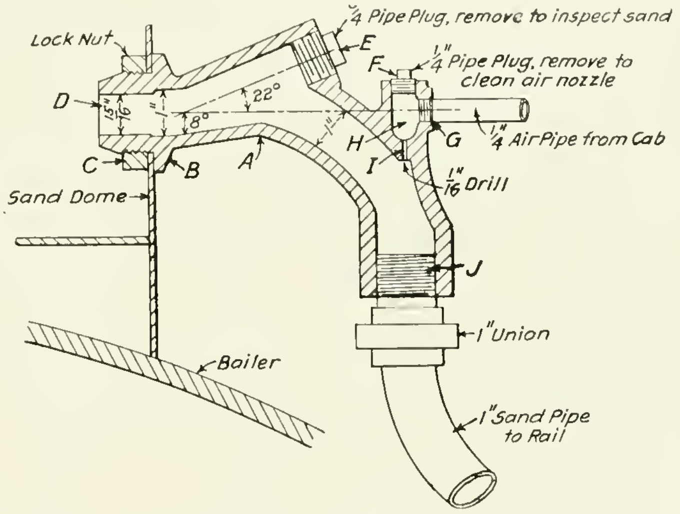
The lathe has a swing over the shears of 23 in. and over the carriage of 15 in. The distance between centers is 3 ft. 6 in. Additional equipment that can be furnished includes a turret on the shears, hand or power feed, a turret on the carriage, a turret toolpost, a pan bed and lubricating outfit.



22-In. Morris Lathe Provided with Quick Change Feed

VACUUM SANDER FOR LOCOMOTIVES

A locomotive sander of simple construction in which the sand is drawn from the dome by the creation of a vacuum instead of being blown by direct air pressure, has been developed by the Fryer Vacuum Sander Company, Tulsa, Okla. The device is arranged for convenience in cleaning should the air nozzle become obstructed or the sand bake at the inlet from the dome.



The Fryer Vacuum Sander

Referring to the sectional drawing of the sander, it will be seen that in order to attach it to the locomotive it is only necessary to cut a hole in the side of the sand dome casing of suitable size to receive the end of the sander, the sander then being locked in place by the application of a lock nut

on the inside of the dome. The lower end of the sander casting is fitted for a 1-in. sand pipe connection which is led into the hand sand pipe by the use of a suitable Y fitting a few inches below the hand sander connection to the dome. The installation is completed by the attachment at *G* of a ¼-in. air pipe from the control valve in the cab.

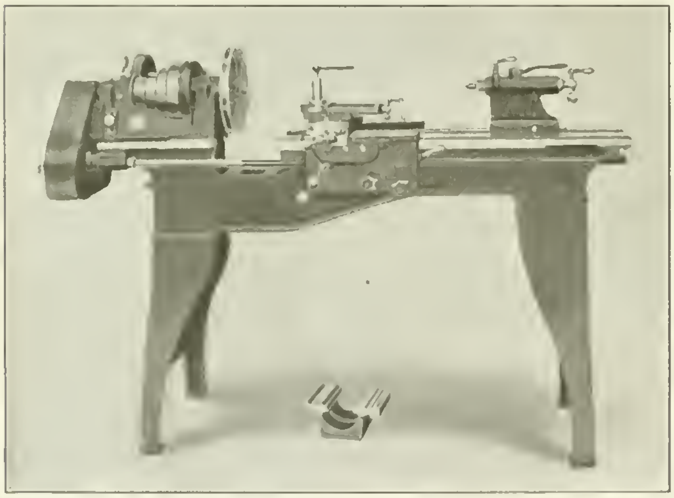
When ready for operation the sand closes the opening *D* into the dome and partly fills the horizontal passage at the left end of the casing, the upward slope of the bottom of the casing preventing it from flowing down the pipe by gravity. On the admission of air pressure at *H*, however, a stream of air is directed downward along the center line of the sand pipe connection through the 1/16-in. nozzle *I*, and a vacuum is created between the nozzle and the dome opening. The sand is thus drawn over the point *A* to be caught by the downward flowing stream of air below the nozzle and blown through the pipe to the rail. The device is said to provide complete control of the flow of sand up to its full capacity, which is the equivalent of a ¼-in. stream of sand, by varying the air admitted through the sander valve.

It will be noted that the sand is admitted to the casing through an opening restricted slightly below the size of the air pipe and the remainder of the passage through the sander itself, so that anything which will enter the sander meets no obstruction to its free passage to the rail and the possibility of clogging is thus reduced to the minimum. The employment of the vacuum principle makes possible the elimination of traps or pockets in the sander, thereby greatly reducing the possibility of clogging or freezing in the device itself. Two cleaning plugs are provided at *E* and *F*.

This device has been in successful operation for some time and is now being installed on a large number of locomotives.

STAR GAP LATHE

The use of heavy, expensive tools for the performance of small machine operations is prevalent in too many railway shops. Sometimes this wastefulness and lack of economy is due to carelessness on the part of the operator, who may have a smaller machine available on which the work could be done. In other cases, as for instance when turning an air compressor piston rod with the piston attached, the very



Gap Lathe Developed by the Seneca Falls Manufacturing Company.

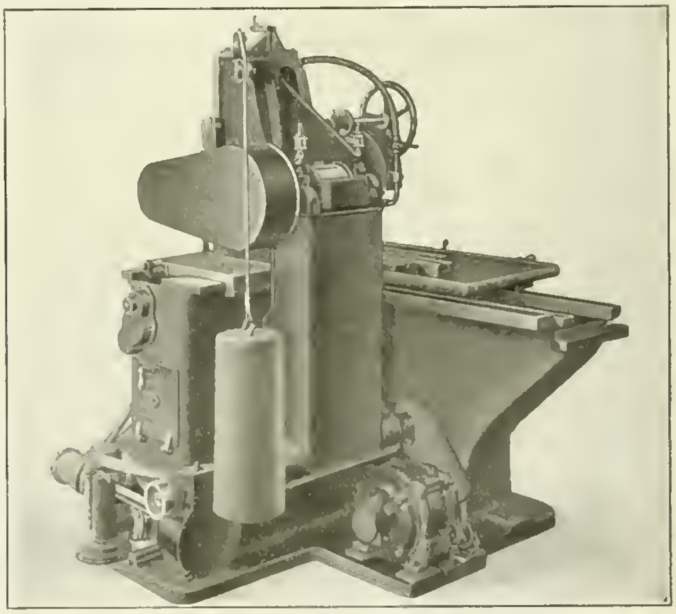
nature of the job itself requires that it be performed on a lathe large enough to swing the piston, whereas the diameter of the rod turned is much smaller. In this case the use of some type of gap lathe is economical practice. Owing to the gap feature, a considerably smaller lathe will be of sufficient capacity to swing the piston head, and the larger lathes can be reserved for the heavy machine operations.

The Seneca Falls Manufacturing Company, Seneca Falls, N. Y., has added to its line of Star screw-cutting lathes two new sizes of gap lathes. These have an 11-in-18-in. swing and a 13-in-21-in. swing, respectively. The bed of the lathe is of the box section type, thoroughly braced by cross webs and heavily reinforced through the gap section to insure accuracy. This feature is well shown in the illustration.

The carriage is provided with a cross slide placed at the left hand for convenience. The cross feed screw is supplied with a micrometer collar, graduated in thousandths of an inch. The apron has a safety device to prevent engagement of the longitudinal feed and the slip nut simultaneously. The lathe has an exceptionally wide range for screw cutting and all standard threads from 3 to 72 per inch can be cut. The standard pipe threads of 11½ and 27 per inch can also be cut. Several attachments can be furnished with the Star gap lathe, including a raising block, quick change gears, taper attachment, motor drive and turrets.

SINGLE MOTOR DRIVEN SURFACE GRINDER

The automatic surface grinding machine illustrated is manufactured by the Diamond Machine Company, Providence, R. I., and a single motor is used to drive both the spindle and the table. Surface grinding machines are sometimes arranged with one motor to drive the spindle, and a second special reversing motor to cause the table to reciprocate. One of the main advantages of the new type of grinding machine illustrated is in the elimination of the special reversing motor. The control switches of such a motor are



Diamond Grinder Equipped with Single Motor Drive

subject to severe service, and it is difficult to get a reversal without more or less shock.

As shown in the illustration, which is a rear view, the initial drive from the motor is through a Morse silent chain and the remainder of the drive is through belting. This is peculiarly adapted to surface grinding machinery, in which smoothness of action is essential to avoid chatter marks on the work. The belt shifting planer type of reversing mechanism provides for smooth running and reverse.

Due to the elimination of the special motor and control box, the grinder can be built at a lower cost. Every precaution is taken to provide against dust and moisture getting into the bearings and careful arrangements are made for the safety of the operator. The water guards are not shown in the illustration, but are furnished with the machine. A guard for the counterweight also is provided.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue, 12,500 copies were printed; that of these 12,500 copies, 11,582 were mailed to regular paid subscribers, 10 were provided for counter and news company sales, 225 were mailed to advertisers, 32 were mailed to employees and correspondents, and 651 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 48,800, an average of 12,200 copies a month.

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In the course of a statement in the Prussian Diet, Herr Deser, minister of public works, hinted at the necessity of reintroducing a piecework system in the state railway shops.

The Missouri, Kansas & Texas has ordered 50 oil-burning Mikado type locomotives for use on the Texas divisions. These will be used for passenger and freight traffic, and it is expected that the first of the locomotives will be delivered in June.

Protection of potatoes from cold is the subject of Farmers' Bulletin No. 1091, just issued by the United States Department of Agriculture. This is a pamphlet of 26 pages profusely illustrated with drawings to show the proper methods of packing potatoes, of fixing board linings in cars and of keeping cars warm by means of stoves in winter.

It is reported that the New York Central and the New York, New Haven & Hartford are each in the market for more than $100,000 worth of miscellaneous machine tools. Recently the Baltimore & Ohio issued a substantial list of machine tools, and it is expected that the Delaware, Lackawanna & Western will be in the market soon for equipment of this kind.

The Railway Association of Canada has announced an embargo on the sending of Canadian freight cars into the United States. Because of the shortage of cars in the United States American railroads are not returning a sufficient number of Canadian cars, according to the association, and the embargo is considered necessary in order to relieve the lumber famine in Canada.

The Chamber of Commerce of Pittsburgh has adopted a resolution condemning efforts to effect a change in the existing system of weights and measures as impractical and inimical to the trade and general commercial interests of the country. This action was taken as the result of the protests of a large number of the most prominent manufacturing interests in the Pittsburgh territory against the pro-metric propaganda which has been carried on by the World Trade Club.

What the general railway strike last year in England cost the companies or the British Government, says the Engineer (London), may be gaged by the fact that the Ministry of Transport statement shows that while September had a balance of £1,096,410 in revenue over expenditure, October had a balance of £924,987 in expenditure over revenue. These figures suggest that the loss was at least £2,000,000. Strike pay cost the National Union of Railwaymen £206,955, and war loan stock to the value of £260,000 had to be sold.

The Mechanical Section of the American Railroad Association has announced in Circular S-III-101 that supplement No. 1 to the Rules of Interchange, effective March 1, 1920, will soon be ready for distribution. This includes changes covered by letter ballots and the modifications recommended by the Committee on Tank Cars and by the Arbitration Committee. The circular also announces that the effective date of section *G* of Rule 3 has been extended to October 1, 1920.

A damage suit brought by a discharged employee of the Great Northern against that company, A. B. Ford, master mechanic and Director General Hines, was thrown out of court on March 2, by the judge of the Butte (Mont.) court. The plaintiff asked for damages in the sum of $21,049 for a violation of contract in dismissing him from railway service for disobedience of orders. The contention of the defendants was to the effect that the director general or the United States government could not be held responsible for any alleged violation of contract prior to January 3, 1918, the time of the dismissal of the claimant.

A number of tests were made recently on the Southern Pacific for the purpose of determining whether superheater locomotives, equipped with 10,000-gal. tenders, can handle full-tonnage trains between Mecca, Cal., and Niland (a distance of 47 miles), and between Niland and Yuma, Ariz. (a distance of 59 miles), without the use of water-cars. The hauling of water-cars over this stretch of desert is continued at a large yearly expense and, notwithstanding the many attempts made to locate water and establish water stations, no satisfactory supply has yet been discovered. The results of the tests have not yet been made public.

The mechanical and electrical features of the new Westinghouse electric passenger locomotives for the Chicago, Milwaukee & St. Paul were explained by N. W. Storer, of the Westinghouse Electric & Manufacturing Company, in an illustrated talk given before the Railway Club of Pittsburgh, on February 26. As the slides were thrown on the screen, Mr. Storer told how each part of the locomotive was

constructed and the reason for the adoption of that particular feature. The construction of the wheel trucks, the method of supporting the cab, the drawbar connection and the method of drive were points of particular interest to the railway men present.

Fifty-eight years of continuous service with the Grand Trunk is the record of George Clark, foreman of the blacksmith shop at the Stratford works, and he is still attending to his duties with regularity. Mr. Clark entered the service of the Grand Trunk at Point St. Charles in 1862, but he has been stationed at Stratford since 1871.

Director General Hines announced on March 3 that all the equipment that was purchased by the Railroad Administration for the various railroads, consisting of 100,000 freight cars and approximately 1,930 locomotives, has been finally allocated and accepted by the various roads. The Division of Finance advises that where railroads were able and willing to pay for the cost of such equipment in cash, this has been done; that in the other instances the government has accepted the equipment trust obligations of the individual carriers whereby the cost is to be repaid in 15 annual installments at six per cent interest. Equipment trust obligations have been accepted from 74 of the railroad companies.

Locomotive engines should not be operated at so high a rate of speed as to cause such a degree of discomfort to enginemen and firemen as to endanger their health or to impair their efficiency. This is the decision of the New York State Public Service Commission, second district, on a complaint of the brotherhoods that consolidation engines used on the milk trains of the New York, Ontario & Western were unsuitable for the speeds required of those trains. After hearing a good deal of conflicting evidence the commission decided that the engines in question should not be run faster than 30 miles an hour, except under emergencies or unexpected delays, when temporarily the rate might be increased to 35 miles an hour. These speeds must not be permitted except when the engines are in first class condition.

The Plumb Plan League has announced the establishment at its Washington office of a Research Bureau under the direction of O. S. Beyer, Jr. One of the important functions of the bureau will be the keeping of accurate records of all members of Congress for the benefit of their constituents. The speeches, attitudes and votes of Senators and Representives will be carefully indexed and recorded so that a complete digest of the record of any member of Congress may be secured on short notice. From time to time the bureau will publish special pamphlets, documents, etc., on matters requiring particular illumination. When legislation is pending, or when railroad rate and wage questions are under consideration, the Research Bureau will endeavor to be of help in compiling statistics, arguments and data "for the purpose of proving the justice and soundness of labor's contentions."

Director-General Hines gave a farewell talk to about 200 members of the Railroad Administration staff at the final dinner of the Railroad Administration Lunch Club, of which W. C. Kendall, manager of car service section, has been president, at Washington, on February 25. Mr. Hines paid high tribute to his associates, saying that they had been the hardest working organization he had ever known, and that the team work and lack of friction in an organization brought together under such circumstances was remarkable. He discussed briefly some of the outstanding developments of federal control, saying that large increases in expenses were in no way attributable to federal control, but that the roads would have been subject to them if they had remained under private management and they would not have had the benefit of economies resulting from unification. He pointed out that the Esch-Cummins bill expressly recognizes some of the advantages of unification and said that while the pendulum will probably swing the other way for a time it will also swing back again and experiences of federal control will have pointed the way.

Because of doubts as to whether Director General Hines and his representatives could continue after March 1 to exercise the authority over the distribution of coal delegated to him by the former fuel administrator, H. A. Garfield, who has since resigned, President Wilson on February 28 issued two executive orders providing for a continuation of Mr. Hines' authority over the "delivery, use, consumption, distribution and apportionment" of coal, and reinstating until April 30, the order of the fuel administrator of November 6, 1917, relative to tidewater transshipment of coal at Hampton Roads, Baltimore, Philadelphia and New York, and for the employment of and co-operation with the Tidewater Coal Exchange, as a common agency to facilitate transshipment and to reduce delays in the use of coal cars and coal carrying vessels, which was suspended on February 20, 1919. J. W. Howe, commissioner of the Tidewater Coal Exchange, Rembrandt Peale, F. M. Whitaker and J. F. Fisher were designated as representatives of the President to carry out the provisions of the order, to exercise the powers of the fuel administrator and also after March 1 the authority vested in the director general of railroads relative to the export of coal from the United States, until April 30.

Boiler Compounds; Their Nature and Use

In the article on boiler compounds, by W. S. Mahlie, published on page 71 of the February issue of the *Railway Mechanical Engineer*, an error occurred in the prices of the chemicals given in Table III. At the top of each column in this table prices were given in dollars, although a footnote to the table stated that prices were in cents. The dollar sign should have been omitted in every case.

Plans for Atlantic City Conventions

The American Railroad Association and the Railway Supply Manufacturers' Association have announced plans for the annual convention to be held in Atlantic City, June 9 to 16, inclusive. The reports of committees of Section III —Mechanical investigating locomotive matters will be received and discussed on Wednesday, Thursday and Friday, June 9, 10 and 11, and reports of committees on car matters will be taken up on Monday, Tuesday and Wednesday of the next week. The sessions of the Mechanical Section will be held in the morning to give time for viewing the exhibits. The Purchases and Stores Section of the American Railroad Association will hold its annual meeting on June 14, 15 and 16, in the Hippodrome.

The Railway Supply Manufacturers' Association has arranged to have exhibits in the balcony over the main building on Young's pier, which will make the total exhibit space approximately 100,000 sq. ft., an increase of 6,500 sq. ft. over 1919. Applications have already been made for practically all the available booths, and a large number of new companies will be represented. All entertainment features will be held on the pier, as was done in 1919.

Erie's Hornell Shops Leased to Private Firm

The Hornell Repair & Construction Company, a concern newly organized for that purpose, on March 6 assumed control of the Erie Railroad shops, roundhouse and car repair yards at Hornell, N. Y. By a contract made on March 1 the new company has leased the shops and will henceforth manage and operate them as a private plant. The officers and employees have been continued in the same positions, the prevailing wage scales, the working conditions and transportation privileges maintained.

The new concern is headed by Hornell business men and its officers consist of Martin F. Woodbury, president; Justin B. Bradley, vice-president; Robert W. Bull, secretary; John F. Nugent, treasurer. Burr L. Smith is a director and Francis M. Cameron attorney.

In the announcement of the step, statements are made that it is hoped that the more direct control of operations will prove more efficient and economical than the former method. It is understood that the shops will be improved and enlarged.

New Reclamation Campaign Instituted on the St. Paul

H. S. Sackett, assistant purchasing agent of the Chicago, Milwaukee & St. Paul, is the author of a new plan being put into effect on the lines of that road, by means of which it is hoped to place reclamation work on a more satisfactory, efficient and economical basis. Mr. Sackett's plan comprises briefly the creation of a system reclamation committee at the road's general headquarters and the establishment of subordinate committees, composed largely of general and division officers, at each of the road's principal shops. The subordinate committees, aided by educational posters, are to supervise local reclamation work, assist in the conduct of educational reclamation compaigns and make studies of the reclamation of various groups of materials.

Mr. Sackett's plan is now being put into operation on the lines of the St. Paul. In the near future it is proposed to hold conferences at Chicago to discuss and develop this reclamation work, and it is proposed thereafter to hold these conferences from time to time and take up the subject of the reclamation of various groups of materials.

Freight Locomotive and Freight Train Costs

The total cost of freight train service, including locomotive service, per 1,000 gross ton-miles, which had been decreasing each month of 1919 up to and including August, showed an increase in September, October, November and December. In December, according to the monthly report of the Operating Statistics Section of the Railroad Administration, it was 139.7 cents, as compared with 124.4 cents in December, 1918, and as compared with 122 cents in November, 1919. In October it was less than for October, 1918. Per locomotive-mile and per train-mile in December the cost was also greater than in December, 1918. The cost of freight locomotive service per locomotive-mile in December was 131 cents, as compared with 121.1 cents in December, 1918. In November it was 119.7 cents. The cost of freight train service per train-mile in December was 185.2 cents, as compared with 171.3 cents in December, 1918. In November it was 170.3 cents. The combined figures for all regions and the comparative figures for 1918 are as follows: (Costs for 1918 have been readjusted for back pay, while the costs for 1919 apply to the month of November only, the back pay applicable to previous months having been eliminated.)

	December 1919	December 1918
Cost of locomotive service per locomotive-mile... (cents)	130.0	121.1
Locomotive repairs	41.6	39.0
Enginehouse expenses	9.3	10.1
Train enginemen	22.3	19.3
Locomotive fuel	53.8	48.6
Other locomotive supplies	3.9	4.0
Cost of train service per train-mile	185.2	171.3
Locomotive repairs } Enginehouse expenses }	57.9	56.4
Locomotive fuel	61.2	55.8
Other locomotive supplies	4.4	4.6
Train enginemen	25.3	22.2
Trainmen	28.8	25.6
Train supplies and expenses	7.6	6.7
Cost of total train service per 1,000 gross ton-miles	....	....
Locomotive repairs } Enginehouse expenses }	43.7	41.0
Locomotive fuel	46.2	40.5
Other locomotive supplies	3.3	3.4
Enginemen and trainmen	40.8	34.7
Train supplies and expenses	5.7	4.9

MEETINGS AND CONVENTIONS

Western Railway Club.—At the April 19, 1920, meeting of the Western Railway Club a paper will be presented by S. W. Mullinix, superintendent of shops of the Chicago, Rock Island & Pacific on Modern Methods of Reducing Cost of Locomotive Repairs.

Master Tinners', Coppersmiths' and Pipefitters' Association.—The sixth annual convention of this association will be held at the Hotel Sherman, Chicago, June 1-4, 1920. Foremen who are not members of the association are also invited to be present at the meeting.

Storekeepers' Annual Meeting.—Section VI, American Railroad Association—Department of Purchases and Stores—will hold its first annual meeting at Atlantic City, N. J., on June 14, 15 and 16. Headquarters will be at the Marlborough-Blenheim Hotel and business sessions will be held in the Hippodrome on the Million Dollar pier.

Members and all persons attending are asked to reach Atlantic City by Saturday, June 12, if possible, in order to see the exhibits and not be obliged to take time from business sessions for that purpose. Badges must be secured, on arrival, from the committee at the pier.

Seventeen subjects are on the program for discussion, as follows, the name of the chairman of the committee in charge being given with each subject:

1. Store department book of rules; J. G. Stuart (C. B. & Q.).
2. Classification of material; C. H. Rost (C. R. I. & P.).
3. Reclamation of material.
4. Material accounting; W. E. Brady (A. T. & S. F.).
5. Commissary; G. C. Smith (U. P.).
6. Cross ties: J. H. Waterman (C. B. & Q.).
7. Stationery; W. D. Stokes, supervisor of stores, United States Railroad Administration, Southern Region.
8. Distribution of material to users; W. D. Stokes.
9. Fuel—purchasing, storage and distribution; S. B. Wright (N. Y. C.).
10. Scrap; handling and sales; G. W. Hayden (N. Y., N. H. & H.).
11. Ice—purchasing, storage and distribution; T. I. Frier (Wabash).
12. Purchasing agent's office records; C. E. Walsh (P. W. P.).
13. Lumber; Wm. Beatty (P. R. R.).
14. Rails; A. A. Goodchild (C. P. R.).
15. Buildings and structures; U. K. Hall, associate manager, stores section, United States Railroad Administration.
16. Supply train operation: A. S. McKelligon (S. P.).
17. Standards; F. D. Reed (C. R. I. & P.).

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention May 4-7, Hotel Sherman, Chicago.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Convention, June 9-16, 1920, Atlantic City, N. J.

American Railroad Association, Section VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Convention June 14-16, 1920, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind. Convention June 1-4, 1920, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koenecke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago. Convention, May 24-27, 1920, Hotel Sherman, Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

F. W. Brazier has been appointed assistant to the general superintendent of rolling stock of the New York Central, with headquarters in New York.

A. E. Calkins, engineer of rolling stock for the corporate organization of the New York Central under federal control, has been appointed superintendent of rolling stock for the Eastern Lines, with headquarters at New York.

J. T. Carroll, general superintendent maintenance of equipment, with headquarters at Baltimore, Md., has had his title changed to general superintendent of motive power.

Robert Collett, assistant manager of the Fuel Conservation section of the Railroad Administration, during federal control, has been appointed superintendent of fuel and locomotive performance of the New York Central.

George T. Depue, who has been appointed mechanical superintendent of the newly created Chicago region of the Erie, was born on December 2, 1872, in Hornell, N. Y., and received his education in the grammar schools. On March 1, 1889, he entered the employ of the Erie as a machinist apprentice. After that he worked as a machinist and extra gang foreman until March 1, 1901, when he was promoted to the position of general foreman of the Bradford division, with headquarters at Bradford, Pa. On August 1, 1901, he was appointed general foreman of the Hornell shop; on July 1, 1903, master mechanic at Hornell; on April 1, 1908, master mechanic at Galion, Ohio; and on August 1, 1913, shop superintendent at Galion, holding that position until July 1, 1916, when he was appointed shop superintendent at Susquehanna, Pa. This is the position he left on March 1, 1920, when the Erie was reorganized and he was appointed mechanical superintendent of the Chicago region.

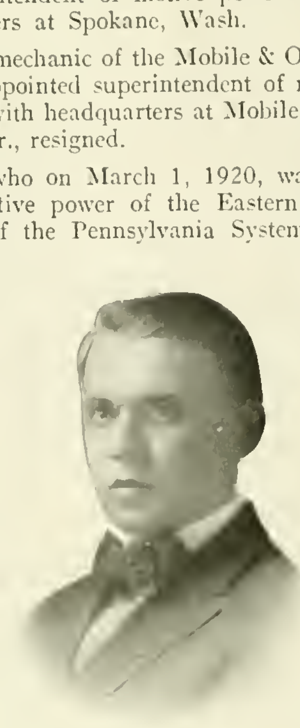
G. T. Depue

Thomas W. Demarest, who has been appointed general superintendent motive power of the Northwestern region of the Pennsylvania, with headquarters at Chicago, was born on March 18, 1868, at Englewood, N. J., and was graduated from Stevens Institute of Technology at Hoboken, N. J., on June 4, 1888. Mr. Demarest began railroad work as a special apprentice in the shops of the Pittsburgh, Cincinnati & St. Louis at Columbus, Ohio. He was later assistant to the master mechanic at Columbus, and on February 1, 1897, was appointed general foreman of the locomotive department of the same shops. He was promoted to master mechanic at the Logansport, Ind., shops on August 1, 1899, and on January 1, 1900, was appointed superintendent motive power of the Pittsburgh, Cincinnati, Chicago & St. Louis. From July, 1903, to March 1, 1920, he was superintendent motive power of the Northwest system of the Pennsylvania Lines West, his headquarters for some years past having been at Pittsburgh, Pa.

J. J. Dowling, general master mechanic of the Eastern district of the Great Northern, with office at St. Paul, Minn., has been appointed superintendent of motive power of the lines west, with headquarters at Spokane, Wash.

G. L. Lambeth, master mechanic of the Mobile & Ohio at Whistler, Ala., has been appointed superintendent of motive power and car equipment, with headquarters at Mobile, Ala., succeeding J. J. Thomas, Jr., resigned.

Edwin B. DeVilbiss, who on March 1, 1920, was appointed superintendent motive power of the Eastern Ohio division, Central region, of the Pennsylvania System, was born on September 13, 1884, at Fort Wayne, Ind. He was graduated from Purdue University in 1908 with the degree of mechanical engineer and entered the employ of the Pennsylvania Lines West on July 1, 1908, as a special apprentice. He was promoted to motive power inspector on January 1, 1911, to electrical engineer of the Northwest system on April 1, 1912, and to assistant engineer of motive power of the Central system on June 1, 1915. At the time of his recent appointment he was assistant engineer of motive power in the office of the general superintendent of motive power of the Lines West, at Pittsburgh, Pa., having held that position since October 15, 1917.



E. B. DeVilbiss

George H. Emerson has been appointed chief of motive power and equipment of the Baltimore & Ohio, with headquarters at Baltimore, Md. Mr. Emerson entered railway service in 1880 as a water boy on the Willmar division of the Great Northern. From 1882 to 1887 he served an apprenticeship at the St. Paul shops, afterwards until 1897 acting consecutively as boilermaker, fireman, engineman and locomotive foreman. From 1897 to 1900 he was general shop foreman and master mechanic of the Dakota and Northern divisions. On the latter date he was appointed general master mechanic of the Western district, and in 1903 superintendent of motive power. He was made assistant general manager of the Great Northern on March 15, 1910, and on October 1, 1912, was appointed general manager. In October, 1917, he left the service of the Great Northern to take charge of the Russian Railway Service Corps, receiving the commission of colonel.

B. J. Farr, superintendent of the motive power and car department of the Grand Trunk Western Lines, has moved his headquarters from Detroit, Mich., to Battle Creek.

Frank H. Hardin, assistant to the federal manager of the New York Central, has been appointed chief engineer of motive power and rolling stock, with headquarters in New York. Mr. Hardin was born on June 14, 1886, in Gainesville, Ga. He was graduated from the Georgia School of Technology in 1908 and then took a post graduate course at Columbia University. All his railroad service has been with the New York Central, he having begun on August 1, 1909, as a special apprentice at the West Albany shops. After several minor promotions, he was made enginehouse foreman at Tupper Lake, N. Y., in June, 1913, and in November of that year was transferred to Utica, N. Y., as assistant foreman, where he remained for one year, until

November, 1914. At that time he was appointed special engineer in the office of the assistant to the president in New York. From March, 1917, to November, 1918, he was master mechanic of the Adirondack division, with headquarters in Utica. On the latter date he was appointed assistant to the federal manager of the New York Central at New York, holding that position until March 1, 1920.

W. C. A. Henry, who has been appointed general superintendent of motive power of the Southwestern region of the Pennsylvania, with headquarters at St. Louis, Mo., was born on October 13, 1873, at Stapleton, Staten Island, N. Y., and was educated at Brooklyn Polytechnic Institute. He started work as a special machinist apprentice with the Pennsylvania at Altoona on March 2, 1891, and on June 1, 1897, was made acting foreman of car inspectors on the Pittsburgh division, afterwards acting consecutively as assistant road foreman of engines, assistant general foreman of the car shop at Altoona, and assistant engineer of motive power until July, 1903, when he was appointed master mechanic at Wellsville, Ohio, on May 1, 1906, being transferred to Columbus, Ohio. From September, 1906, to March 1, 1920, Mr. Henry was superintendent of motive power of the Southwest system of the Pennsylvania Lines West, with headquarters at Columbus, Ohio.

W. C. A. Henry

Frederick W. Hankins, who was appointed assistant chief of motive power (locomotive), with headquarters at Philadelphia, Pa., when the Pennsylvania was reorganized, was born on January 1, 1876, at London, England. Mr. Hankins was educated in the public schools of Foxburg, Pa., and entered the service of the Pittsburgh & Western, then part of the Baltimore & Ohio, as a machinist apprentice in April, 1891. He was transferred to the Baltimore & Ohio at Allegheny, Pa., in 1894, and in July, 1897, entered the employ of the Allegheny Valley at the Forty-third street shops in Pittsburgh, Pa., where he served successively as machinist, leading machinist and acting roundhouse foreman until April, 1905, when he was transferred to the Cumberland Valley as enginehouse foreman at Chambersburg, later being machine shop foreman and general foreman until about June, 1916, when he was appointed master mechanic. Early in 1919 Mr. Hankins was transferred to Altoona, Pa., as master mechanic of the Pennsylvania, and held that position until March 1, 1920. Mr. Hankins' present headquarters are at Philadelphia, Pa., instead of at Atlanta, as stated on page 181 of the March *Railway Mechnical Engineer*.

William Kelly, assistant superintendent motive power of the Great Northern, has been appointed general superintendent of motive power, with headquarters at St. Paul, Minn., succeeding A. C. Deverell.

R. L. Kleine, formerly chief car inspector of the Pennsylvania, with office at Altoona, Pa., who since March 1, 1920, has been assistant chief of motive power (car), now has his headquarters in Philadelphia, Pa., instead of Altoona, as it was incorrectly given in the list of officers published on page 181 of the March *Railway Mechanical Engineer*.

W. F. Kuhlke, master mechanic of the Charleston & Western Carolina, with headquarters at Augusta, Ga., has been appointed superintendent motive power, with the same headquarters.

L. P. Michael, chief draftsman in the motive power and car departments of the Chicago & North Western, has been appointed mechanical engineer with headquarters in Chicago, succeeding J. C. Little, resigned.

B. J. Peasley, superintendent motive power of the Vicksburg, Shreveport & Pacific at Monroe, La., has been appointed superintendent motive power of the St. Louis Southwestern, with office at Tyler, Tex. A photograph of Mr. Peasley and a sketch of his railroad career were published in the *Railway Mechanical Engineer* for December, 1919, on page 749.

C. G. Slagle, assistant mechanical engineer of the Cincinnati, Indianapolis & Western, has been appointed acting superintendent motive power, with headquarters at Indianapolis, Ind.

C. E. Peck, assistant superintendent motive power of the Oregon-Washington Railroad & Navigation Company, has been appointed superintendent motive power and machinery, succeeding J. F. Graham, deceased.

J. W. Senger, master car builder of the New York Central Lines west of Buffalo, with headquarters at Collinwood, Ohio, has been appointed superintendent of rolling stock of the Lines West, with headquarters at Buffalo, N. Y.

P. F. Smith, Jr., who has been appointed works manager of the Pennsylvania at Altoona, was born on August 1, 1870. After graduating from Warrall's Technical Academy in June, 1887, he was employed by the Pennsylvania as an apprentice in the shops at Altoona, Pa. After several minor promotions he was appointed assistant road foreman of engines on the Pittsburgh division in February, 1892. On February 1, 1895, he was appointed assistant master mechanic at the Fort Wayne, Ind., shops, and in November, 1896, was promoted to the position of master mechanic of the Crestline, Ohio, shops and the Toledo division. From January 1, 1900, to December 31, 1911, he was master mechanic at several shops of the Pittsburgh, Cincinnati, Chicago & St. Louis, and on January 1, 1912, was appointed superintendent of motive power of the Central system, Pennsylvania Lines West, which position he held until January, 1917, when he was appointed general superintendent of motive power of the Lines West, with headquarters at Pittsburgh, Pa. When the Pennsylvania system was reorganized on March 1, Mr. Smith was appointed works manager of the Altoona shops, reporting direct to J. T. Wallis, the chief of motive power, with the authority and responsibility that the manager of an industrial manufacturing plant would have.

P. F. Smith, Jr.

R. Porter Smith, chief draftsman of the Georgia Railroad, has been appointed mechanical engineer of that road, the Atlanta & West Point and the Western Railway of Alabama, with headquarters at Augusta, Ga. Mr. Smith

was born on January 3, 1875, at Olean, N. Y., and received his education in the public schools there, entering railway work in February, 1899, with the Western New York & Pennsylvania at Olean. When that road became part of the Pennsylvania he continued with it, being employed in the boiler, machine and erecting shops until August, 1901. He was then transferred to the drawing room, remaining there until October, 1903, when he was appointed roundhouse foreman, resigning in February, 1906, to go with the Georgia Railroad as chief draftsman. He acted in that capacity continuously from April 2, 1906, until March 1, 1920, the time of his recent appointment as mechanical engineer.

J. J. Tatum, general supervisor of car repairs for the United States Railroad Administration, has returned to the service of the Baltimore & Ohio, as superintendent of the car department, having headquarters at Baltimore, Md.

F. O. Walsh has been appointed superintendent of motive power of the Atlanta & West Point, the Western Railway of Alabama and the Georgia Railroad, with headquarters at Atlanta, Ga.

W. O. Thompson, superintendent of rolling stock of the New York Central Lines west of Buffalo, with headquarters at Cleveland, Ohio, has been appointed general superintendent of rolling stock, with office at Buffalo, N. Y. Mr. Thompson was born in Clayton, Mich., in 1863 and was graduated from Adrian (Mich.) high school. He began railroad work in 1882 on the Fort Wayne, Jackson & Saginaw, which later became a part of the Lake Shore & Michigan Southern. From 1884 to 1890 he served as a locomotive engineman and then was appointed traveling engineer, remaining in that position until August, 1893. He was then for some years an engine despatcher and in 1901 was appointed general locomotive inspector of the New York Central & Hudson River. The following year he was appointed superintendent of motive power on the Rome, Watertown & Ogdensburg division, and in 1907 became district master car builder at East Buffalo, N. Y. He was appointed superintendent of rolling stock of the New York Central Lines West of Buffalo during 1915, from which position he was recently promoted to general superintendent of rolling stock for the entire system.

W. O. Thompson

Henry Yoerg, assistant superintendent motive power of the Great Northern, has been appointed superintendent motive power of the lines east, with headquarters at St. Paul, Minn. Mr. Yoerg was born on June 17, 1872, at St. Paul, Minn., and was graduated from Massachusetts Institute of Technology, in the class of 1895. He began railway work in 1897 as a draftsman on the Great Northern, afterwards being consecutively assistant engineer, superintendent of the machine shops at Havre, Mont., and superintendent of machine and car shops at St. Paul, until 1908, when he was advanced to the position of mechanical engineer. During 1917 he was appointed assistant superintendent of motive power, with headquarters at St. Paul, which position he held until his recent appointment.

J. M. Henry, who has been appointed general superintendent of motive power of the Eastern region of the Pennsylvania, with headquarters at Philadelphia, Pa., was born on October 10, 1873. He entered the service of the Pennsylvania Railroad as a special apprentice in the Altoona machine shops on May 5, 1889, and served as an apprentice until September 1, 1896, when he entered Purdue University, being furloughed from the shops during the school term each year. He was graduated in June, 1900, and then became a special apprentice in the office of the assistant engineer of motive power at Altoona. A year later he was promoted to motive power inspector at Altoona, and in February, 1902, was made assistant engineer of motive power of the Erie division and Northern Central Railway at Williamsport, Pa. From July 1, 1903, to December, 1913, he was master mechanic at various shops. On the latter date he was promoted to superintendent of motive power of the Western Pennsylvania division, and on May 1, 1916, was transferred to the operating department as assistant superintendent of the Pittsburgh division, on April 15, 1917, being transferred to the New York division. About October of that year he was appointed assistant general superintendent of motive power at Altoona, holding that position until March 1, 1920, when he was appointed one of the four regional general superintendents of motive power.

J. M. Henry

Amos C. Davis, who has been appointed superintendent motive power of the Southern division, Eastern region, of the Pennsylvania system, was born on March 20, 1876, in Altoona, Pa., and received his education in public and private schools in Indiana county, Pa. His entire railroad service, dating from April 3, 1893, has been with the Pennsylvania, his first position being that of machinist apprentice at the Altoona shops. At the end of his apprenticeship he was employed as a machinist for about two years and was then made gang leader in the erecting shop. After several minor promotions he was appointed acting assistant master mechanic at Altoona on March 8, 1909, and on April 1, 1910, foreman of the miscellaneous shop. For five years from July, 1912, to July, 1917, he was general foreman of the locomotive erecting shop at Altoona, on the latter date being made general foreman at East Altoona, and in October of that year was appointed general foreman of the Altoona machine shop. On October 21, 1918, Mr. Davis was appointed master mechanic of the Maryland division, with headquar-

A. C. Davis

ters at Wilmington, Del., holding this position at the time of the recent reorganization of the Pennsylvania system.

H. H. Maxfield, who was works manager of the Pennsylvania Railroad at Altoona, Pa., has been appointed one of the four regional general superintendents of motive power, having jurisdiction over the Central region, with headquarters at Pittsburgh, Pa. A photograph of Mr. Maxfield and a sketch of his railroad career were published in the *Railway Mechanical Engineer* for September, 1919, on page 561.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Frank J. Dailey has been appointed assistant master mechanic of the Erie at Dunmore, Pa.

Albert J. Davis, formerly master mechanic of the Erie at Jersey City, N. J., and recently shop superintendent at Galion, Ohio, has again been appointed master mechanic at Jersey City, succeeding F. H. Murray.

M. J. Flanigan, master mechanic of the Great Northern at Everett, Wash., has been appointed general master mechanic of the Eastern district, with office at St. Paul, Minn., succeeding J. J. Dowling.

J. B. Irwin, master mechanic of the Chicago, Burlington & Quincy at Casper, Wyo., has been transferred to Alliance, Neb., succeeding G. E. Johnson.

G. E. Johnson, master mechanic of the Chicago, Burlington & Quincy at Alliance, Neb., has been appointed master mechanic at Sheridan, Wyo., succeeding F. E. Kennedy deceased.

George C. Jones has been appointed general road foreman of engines of the Atlantic Coast Line, with headquarters at Florence, S. C.

C. E. Melker has been appointed acting master mechanic of the Chicago, Burlington & Quincy at Casper, Wyo., succeeding J. B. Irwin.

Roy R. Herrick, whose appointment as master mechanic of the Detroit, Bay City & Western, with headquarters at Bay City, Mich., was announced in these columns last month, was born on November 25, 1890, at Jackson, Mich., and was educated in the public schools of Jackson. He has been engaged in railroad work since the spring of 1908, when he took employment with the Michigan Central as a machine operator in the shops at Jackson. Later he was transferred to the roundhouse as an air brake repairman, and then to the passenger terminal at Kalamazoo, Mich. Two years later he returned to the roundhouse at Jackson, where he was employed as a machinist. On January 1, 1918, he went with the Detroit, Bay City & Western, and was recently appointed master mechanic.

R. R. Herrick

Everett O. Smith, whose appointment as master mechanic of the Louisiana & North West, with office at Homer, La., has already been announced in these columns, was born at Chicopee, Mass., and was educated in the public schools of Marshalltown, Iowa. He has been engaged in railroad work since July 1, 1882, when he entered the employ of the Iowa Central as a machinist apprentice. In April, 1883, he went to the Chicago shops of the Chicago & North Western and was made gang foreman in 1887. In 1894 he was promoted to the position of foreman of shops at Belle Plaine, Iowa, and was later transferred in that capacity to Council Bluffs, Iowa, and West Chicago, Ill. In 1902 he became general foreman of the Iowa, Illinois & Indiana Railway at Kankakee, Mich., and in 1903 accepted the position of master mechanic of the St. Louis & Hannibal at Hannibal, Mo., which he held continuously since that time until he received his recent appointment on the Louisiana & North West.

Harry F. Martyr, formerly general foreman of the locomotive shops of the Chicago, Rock Island & Pacific at Horton, Kan., has been appointed master mechanic of the St. Louis & Hannibal, with office at Hannibal, Mo. Mr. Martyr was born on August 9, 1876, at Cosgrove, England. In 1890 he entered the employ of the London & Northwestern as a machinist apprentice. He came to America in September, 1897, and took employment with the Missouri Pacific as a machinist. He was later employed by the St. Louis-San Francisco as machine shop foreman, roundhouse foreman and general foreman. From 1907 to 1911 he was general foreman of the locomotive and car departments of the Detroit, Toledo & Ironton at Jackson, Ohio, and for the last eight years was with the Chicago, Rock Island & Pacific, his last position with that road being general foreman of the locomotive shops at Horton, Kansas. During the latter part of 1919 he was appointed master mechanic of the St. Louis & Hannibal.

H. F. Martyr

J. A. Wright, general foreman on the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic at Tacoma, Wash., succeeding G. E. Cessford, transferred to a similar position at Bellingham, Wash. Mr. Wright was born on June 8, 1880, at Foxburgh, Pa. He received his education in the public schools of Kansas City, Kan., and also attended Puget Sound University, Tacoma, Wash. In 1899 he began railroad work as a fireman on the Northern Pacific. He later served a machinist apprenticeship on the Tacoma Eastern, and then worked as machinist, locomotive fireman and engineman on that road, until 1910, since which time he has been with the Chicago, Milwaukee & St. Paul, latterly as roundhouse foreman and general shop foreman.

J. A. Wright

CAR DEPARTMENT

Alfred Herbster, division general foreman of the car department of the New York Central, Lines West of Buffalo, at Englewood, Ill., has been appointed assistant master car builder of the Fourth district, Western Lines, with the same headquarters.

James Reed, assistant master car builder of the New York Central, Lines West of Buffalo, with headquarters at Englewood, Ill., has been appointed master car builder of the Fourth district, Lines West, with the same headquarters at Englewood.

George Thomson, master car builder of the New York Central Lines West, with headquarters at Englewood, Ill., is now master car builder of the Third district, Lines West, with headquarters at Collinwood, Ohio.

SHOP AND ENGINEHOUSE

James A. Anderson has been appointed shop superintendent of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., succeeding A. N. Lucas, resigned. Mr. Anderson was born at Delas Island, Md., July 9, 1883. He completed his education at the Maryland State College, graduating with the degree of mechanical engineer in 1904, and entered the service of the Baltimore & Ohio as a special apprentice at the Mount Clair shops. He completed his special apprenticeship in 1906 and served as a material inspector in the test bureau until early in 1907, when he was transferred to Garrett, Ind. Here he served successively as a machinist, assistant foreman and roundhouse foreman until March, 1909, then being transferred to Holloway, Ohio, as general foreman of the locomotive and car department. In April, 1912, Mr. Anderson was transferred to Wheeling, W. Va., as motive power inspector, and about a year later was promoted to assistant road foreman of engines. In April, 1914, he was appointed master mechanic of the Cleveland division of the Baltimore & Ohio, continuing in this capacity until July, 1916, when he was transferred to Grafton, W. Va., as master mechanic of the Monongah division. After a little more than two years at Grafton, Mr. Anderson was transferred to the Wheeling division, with headquarters at Benwood, W. Va., where he served as master mechanic until July, 1919. He was then transferred to the Baltimore & Ohio shops at Pittsburgh, Pa., and appointed assistant superintendent in charge of the locomotive department. He continued in the service of the Baltimore & Ohio in this capacity until February 1, 1920, when he left to enter the service of the Chicago, Milwaukee & St. Paul, as shop superintendent at Milwaukee.

Frederick H. Murray, master mechanic of the Erie at Jersey City, N. J., has been appointed shop superintendent at Susquehanna, Pa., succeeding G. T. Depue, recently appointed regional mechanical superintendent of the Chicago region.

PURCHASING AND STOREKEEPING

C. S. Marshall has been appointed general storekeeper of the St. Louis Southwestern, with headquarters at Tyler, Tex.

OBITUARY

W. R. Shoop, manager of purchases and stores of the Buffalo, Rochester & Pittsburgh, with headquarters in Rochester, N. Y., died recently at his home in Rochester. He was 65 years old.

J. F. Graham, superintendent of motive power of the Oregon-Washington Railroad & Navigation Company, with headquarters at Portland, Ore., died recently at his home in that city at the age of 71 years.

SUPPLY TRADE NOTES

E. G. Middleton has been appointed advertising manager of the Colburn Machine Tool Company, Franklin, Pa., manufacturer of vertical boring mills and heavy-duty drilling machines.

W. S. Atkinson, for many years purchasing agent for the Kansas City Southern, has been appointed manager of the railway sales department of the Cook Paint & Varnish Company, Kansas City, Mo.

A. G. Williams, manager of the export department of the American Steel Foundries, Chicago, Ill., sailed from Seattle, Wash., on March 1 for China and Japan, to develop new business in those countries.

Duncan W. Fraser, managing director of the Montreal Locomotive Works, Ltd., on March 1, 1920, was elected vice-president in charge of sales of the American Locomotive Company and vice-president in charge of domestic sales of the Montreal Locomotive Works, Ltd., with headquarters at New York, succeeding J. D. Sawyer, who has resigned to become vice-president of the banking firm of Morton & Co., Inc. Mr. Fraser was born in Pictou county, Nova Scotia, Canada, in 1875, of Scotch ancestors. He was educated in Nova Scotia public schools and at the age of 18 went to Providence, R. I., where he served a four-year apprenticeship course in the shops of the Rhode Island Locomotive Works, later the Providence plant of the American Locomotive Company. With the exception of three years in the service of the Brown & Sharpe Manufacturing Company, Providence, R. I., he continued in the service of the locomotive works until 1904. In that year the Montreal Locomotive & Machine Company, of Montreal, was bought by the American Locomotive Company, and Mr. Fraser was transferred to that plant, serving consecutively as gang boss, sub-foreman and assistant foreman, until 1906, when he was appointed general foreman of the machine departments. In 1908 he was appointed assistant superintendent and later served as superintendent, until December, 1910, when he was made works manager. On February 15, 1917, he was appointed general manager of the Montreal Locomotive Works, Ltd., in charge of sales and manufacturing, and in November, 1919, he was appointed managing director of that company.

D. W. Frazer

The Cincinnati Automatic Machine Company, Cincinnati, Ohio, has purchased from the Windsor Machine Company, Windsor, Vt., the manufacturing, selling and patent rights of the Gridley automatic multiple drilling machine.

At a recent meeting of the stockholders of the Buffalo Forge Company, Buffalo, N. Y., new officers were elected as follows: Henry W. Wendt, president; Edgar F. Wendt, vice-president and treasurer; Henry W. Wendt, Jr., vice-president and secretary; C. A. Booth, vice-president and sales man-

ager. The new directors include the above named officers and in addition H. S. Whiting.

Leslie R. Pyle, supervisor of the Fuel Conservation Section of the United States Railroad Administration, with office at Chicago, has been elected vice-president of the Locomotive Firebox Company, Marquette building, Chicago.

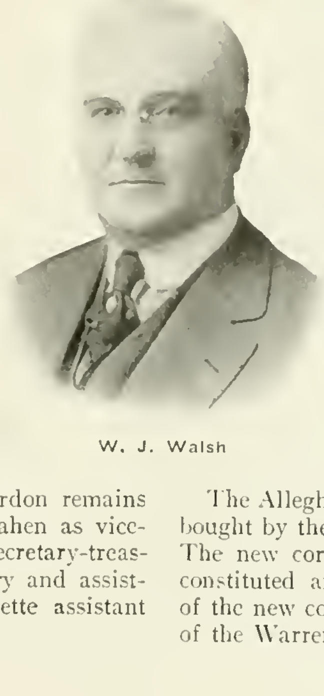
Franklin Murphy, former governor of New Jersey and chairman of the board of directors of the Murphy Varnish Company, Newark, N. J., died on February 24, at Palm Beach, Fla. He was born in Jersey City, on January 3, 1846, and was educated in the Hudson county schools and at Newark Academy. In 1901 he received the degree of doctor of laws from Lafayette College and the following year the same degree from Princeton University. Mr. Murphy served in the United States army during the Civil War, part of the time as a lieutenant; at the close of hostilities he began the manufacture of varnish at Newark, N. J. In 1891 the Murphy Varnish Company was incorporated, with Mr. Murphy as president. He had been prominent in Republican politics since 1892, and in 1901 was elected to the governorship of New Jersey, which office he held for three years. His son, Franklin Murphy, Jr., is now chairman of the executive committee of the Murphy Varnish Company.

F. Murphy

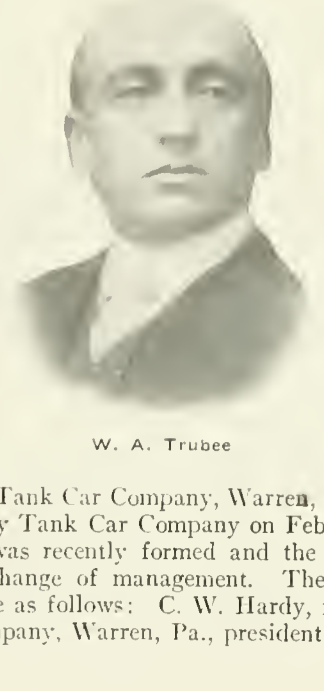
Galena Signal Oil Company Elects New Officers

At the annual meeting of the Galena Signal Oil Company, Franklin, Pa., on February 24, L. J. Drake was elected president to succeed J. S. Cullinan, and W. A. Trubee, district manager at New York, and W. J. Walsh, district manager at Chicago, were elected vice-presidents, all with the same headquarters as formerly. L. F. Jordon remains as vice-president at New York and J. E. Linahen as vice-president at Franklin; J. French Miller as secretary-treasurer at Franklin, L. E. Stull assistant secretary and assistant treasurer at Franklin, and C. W. Hochette assistant secretary and assistant treasurer at New York.

L. J. Drake



W. J. Walsh



W. A. Trubee

Lauren J. Drake, the new president, with headquarters at New York, was born on August 27, 1880, at Keokuk, Iowa. He was educated in the public schools of Omaha and Chicago, and in 1899 graduated from Shattuck Military School, Faribault, Minn. After leaving school he entered the oil business and acquired a general knowledge of it in all departments during his service of five years with several companies. In 1905 he went to the Galena Signal Oil Company and remained as a representative of that company in the Middle West, until 1916, when he came to New York as vice-president.

W. A. Trubee was born in Bridgeport, Conn., on March 22, 1867. He received his early education in Bridgeport private schools, and later attended Greylock Institute at South Williamstown, Mass. He entered the service of the Galena-Signal Oil Company on February 1, 1898, as sales representative at Bridgeport, Conn. On May 1, 1912, he was transferred from Bridgeport to the New York office, and on March 1, 1919, was appointed district manager at New York, which position he held until his recent election as vice-president and director of the same company.

The Mono Corporation of America, 48 Coal and Iron Exchange, Buffalo, N. Y., announces that it has purchased the entire stock of Mono apparatus and accessories from the F. D. Harger Company, Buffalo, N. Y., including all rights for the manufacture and sale of Mono apparatus for the automatic analysis of CO_2, CO and other gases.

H. G. Cook, formerly general storekeeper of the Southern Pacific Company, San Francisco, has entered the railway supply business and opened offices in San Francisco, Cal., representing the following companies on the Pacific Coast: Union Asbestos & Rubber Manufacturing Company, Dearborn Chemical Company, Chicago Railway Equipment Company, Bradford Draft Gear Company, Pyle National Headlight Company, National Waste Company.

Improvements and remodeling to cost approximately $3,500,000 are being carried out at the car works of the Pullman Company. The improvements include a new three-story building of mill construction and a new press building, 80 ft. by 200 ft. The old foundry buildings are being remodeled to furnish additional space. The purpose of the improvements is to provide adequate facilities for the manufacture of automobile bodies.

The Allegheny Steel Tank Car Company, Warren, Pa., was bought by the Allegheny Tank Car Company on February 2. The new corporation was recently formed and the transfer constituted an entire change of management. The officers of the new company are as follows: C. W. Hardy, formerly of the Warren Oil Company, Warren, Pa., president; H. W.

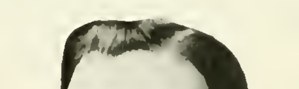
Conarro, general manager, Struthers Wells Company, Warren, vice-president; James P. Rogers, formerly general manager of the Rogers Shear Company, Warren, treasurer; H. R. McClure of the firm of McClure & Smith, Warren and Sunbury, Pa., secretary. The policy of the new company includes general enlargement of the facilities of the plant both in the maunfacturing of new cars and in its repair department. One feature of the new company will be its leasing department, which it will conduct for the benefit of its patrons.

Joseph M. and James J. Flannery

Joseph M. Flannery and James J. Flannery, pioneers in the vanadium industry and the organizers of the Flannery Bolt Company and American Vanadium Company, died within three weeks of each other in Pittsburgh. Joseph M. Flannery was 52 years old. His death occurred on February 18, after an illness of seven months, while his brother died suddenly on March 6, at the age of 66, although he had been in poor health for over a year, but had been active in his business affairs up to the day of his death.


J. M. Flannery

Joseph M. Flannery, who was also president of the Standard Chemical Company, was born in Pittsburgh. In 1904, with his brother, he began a tour of the world, seeking to discover a process whereby unbreakable bolts might be made. An analysis of the metal composing the fencing foils used in Sweden resulted in the discovery of vanadium. To the Flannery brothers is due the introduction of vanadium in the steel industry, marking an epoch in the advance of steel making. Convinced of the value of vanadium for this purpose, they obtained control of an enormous deposit of vanadium ore in the Andes of Peru, and successfully introduced its application in the manufacture of alloy steel, especially for automobile construction and certain locomotive parts, as frames, driving axles, connecting and piston rods. When the American Vanadium Company was sold a few months ago to the Vanadium Corporation of America, controlled by Charles M. Schwab and J. Leonard Replogle, it controlled about 90 per cent of the world's supply of vanadium. Joseph M. Flannery was also interested in the production of radium, and in 1911 organized the Standard Chemical Company, the world's largest producer of radium. At the time of his death he was also working to develop the commercial use of uranium in steel and other metals.


J. J. Flannery

James J. Flannery was the executive head of the Flannery Bolt Company, Pittsburgh, manufacturers of the Tate flexible staybolt, and was president of the American Vanadium Company. He was also interested in coal mining and was president of the Meadowlands Coal Company and the Montour & Lake Erie Coal Company.

The American Steam Conveyor Corporation, Chicago, announces that arrangements have been made with the Wellman Bibby Company, Ltd., 36 Kingsway, London, W. C., 2, England, to act as its representative in Great Britain and Ireland for the sale of the American steam ash conveyor. The Wellman Bibby Company intends to manufacture the American steam ash conveyor in England. This company is well known in the British Isles and handles the sale of a number of American engineering products there.

Automatic Straight Air Brake Company Starts Active Manufacturing

The Automatic Straight Air Brake Company announces that it has completed arrangements with Kidder, Peabody & Co., of New York and Boston, John F. Alvord, president of the Torrington Manufacturing Company and Hendee Manufacturing Company, and Geo. W. Goethals & Co., Inc., for the financing and manufacturing of its brakes. These three interests have purchased a controlling interest in the company and will immediately establish a plant for the manufacture of the brake.


S. G. Neal

John F. Alvord has been elected president. Harry I. Miller, who has been associated with the company from its inception, will be vice-president, in charge of sales. Harry B. Hunt, formerly of the engineering department of the American Locomotive Company and more recently a colonel in the Production Department of the Ordnance Bureau, has been elected vice-president and treasurer, in charge of manufacturing.

With the new organization the company will be prepared to enter upon the production of the automatic straight air brake on a large scale.

Spencer G. Neal, who is chief engineer of the company under its new organization, is the inventor of the automatic straight air brake and the man who has been in charge of its testing and development. He was born at Humboldt, Kan., in 1883. His family moved to southern California when he was two years old and he was educated in the public schools there. He entered railway service in 1898 and served as a machinist apprentice in the San Bernardino, Cal., shops of the Atchison, Topeka & Santa Fe. He then became a machinist and was for a time engaged in the installation of stationary machinery. Having then worked out the idea of the new brake, he spent from 1910 to 1912 on lines now part of the San Diego & Eastern, on which road the first tests of the brake were made. In 1913, he continued these tests on the Arizona Eastern, working out its development by means of passenger train tests between Globe, N. Mex., and Bowie, Ariz. He also continued these tests on a track at Los Angeles. He went to New York in 1914 and has had his headquarters in that city since, with the exception of time spent on tests of the air brake on the Atchison, Topeka & Santa Fe at La Junta, Colo., and on the Virginian.

Railway Mechanical Engineer

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The High Cost of Publishing

In 1832 when the American Railroad Journal, the forerunner of the *Railway Mechanical Engineer*, was founded the subscription price was three dollars a year. In 1837 the journal was changed to a weekly and the price was increased to five dollars. Probably none of our readers remember when the change in the subscription price to two dollars went into effect. For many years this has remained unchanged; but recent increases in the cost of both labor and materials have been so great that the publishers are now forced to increase the subscription price to three dollars in the United States, east of the Mississippi and in Mexico and four dollars west of the Mississippi, in Canada and foreign countries. The increase in the subscription price beyond the Mississippi is due to discrimination against that section of the country embodied in an Act of the Congress which provides for geographical zone rates and progressive increases. The publishers regret this; but the action of the government leaves no alternative.

To some of our readers it may come as a surprise to learn that even the new subscription price will not pay the cost of the paper alone. The price of this one item has increased over 200 per cent and the end does not seem in sight. The increases in the cost of material and labor are matters which are probably of minor interest to our readers, however, and are mentioned only to avoid the charge of profiteering. The editors realize that the subscribers are most concerned with the way in which the publication covers its field. It will be our endeavor to make the *Railway Mechanical Engineer* worth all that it costs to our readers and the editors will welcome suggestions for improvement that will make it more valuable to railroad men.

The Importance of the Foreman

In the past many railroads have been open to criticism because of their failure to accord to men in the minor supervisory positions either the compensation or the recognition to which they were entitled. The status of the foremen in the mechanical department has been improved during the past two years. It is to be hoped that conditions will continue to grow better and that a real incentive will be created so that the most competent and ambitious workers will be induced to strive for promotion and to make the most of their opportunities for further advancement. The lack of personal interest on the part of the higher officers is often responsible for a feeling of indifference among the foremen, which has a decidedly bad effect on the men under them. In this connection Dr. Hollis Godfrey recently said: "The one man most vitally affecting the workman is the foreman. When industry adopts education, when it teaches its management and its foremen to teach, it will eliminate many of the major causes of labor trouble. This will be done not merely through the development of the good fellowship that is inevitable. It will follow as a natural result of giving every man a real chance. When the foreman is taught by his industry and in turn becomes a teacher of the men under his orders, obstacles to each man's rise will be removed. Every man will have the same chance to progress. Nothing makes more difference in industrial unrest than the foreman; nothing can serve better to help industry and the workman than to make him a teacher."

Under present conditions the majority of general officers are burdened with a mass of detail which should be handled by their subordinates. The foremen, instead of being minor executives, are little more than clerks. This condition should not exist if the higher officers would accept Doctor Godfrey's

suggestion. Instead of throwing the foreman on his own resources, giving him little authority and expecting little of him, the roads should take steps to develop the foreman's executive ability, teach him how to handle men and outline the general policy which he should follow. With such training the foreman could be given more authority, more questions could be settled locally and the higher officers would be relieved of a large proportion of the detail work with which they are now burdened.

Bronze and Babbitt Bearings

In an article on bronze and babbitt bearings appearing in this issue, the author, who is a manufacturer of bearings, has aptly referred to the scrap pile as the laboratory of experience and has commented on the lack of suitable bearing testing machines. If it is a fact that the value of such testing machines as we now have lies mainly in the testing of the lubricant, the design of a practical machine for testing the physical properties of journal bearings would appear to offer an excellent field for further development. The statement that the application of a single formula may result in a large variation in the structure of the bearings caused by different pouring temperatures or rates of cooling, and that consequently analysis is a faulty basis on which to purchase bearings, may lead to some discussion among our readers. It is also stated that conservation of tin during the war caused the United States Railroad Administration to specify high-lead bearings for the new cars purchased and as this resulted in an unusually soft bearing there is some question as to how soon these bearings will require replacement. Now that the cars to which these bearings were applied have been in operation some time it would be interesting to know what results are being obtained from these bearings in actual service.

The Service of Supply

Lack of material with which to complete repairs to equipment held in shops is perhaps the most frequent complaint heard from foremen and shop superintendents; it is also one of the best excuses ever offered for not getting the power out in time to suit the operating department. It would be difficult to make a comparison between railroad and industrial shops without observing an unsatisfactory condition on the railroad, with respect to material supply, that cannot altogether be accounted for by the greater diversity of work encountered on the railroad. This view, however, does not take into consideration the fact that on any railroad the shops include many small units scattered over a wide territory as contrasted with industrial enterprises, which are generally concentrated within a single shop or group of buildings thus making it possible to provide at all times an adequate supply of material without accumulating an excessive stock. The shop foreman does not always appreciate just how expensive it is to maintain a stock of material that would be large enough to meet any possible requirement. In the eyes of the shop, every delay to important work on account of a shortage of material tends to overshadow any possible benefit obtained through carrying the smallest possible stock of all materials.

On the other hand it is possible for the stores department to overlook the loss that may be occasioned if material is not always on hand when it is needed. The general storekeeper or purchasing agent can usually carry his point with the management because he is able to produce a convincing statement showing the amount of money that can be saved by means of a reduction in material stocks, but it is next to impossible for the shop superintendent to prove in dollars and cents just what loss has been occasioned by equipment held in the shop waiting for material or to demonstrate what could actually be saved through increasing certain quantities of material carried in stock.

This is a situation which admits of further study on the part of the railroads with a view to striking a proper balance between the objectives of the mechanical and the stores departments. A better mutual understanding of the problems of both departments with respect to the service of supply would be helpful.

Overcoming Rising Costs

For many years preceding the war the development of the locomotive may be said to have kept ahead of the times. The war brought locomotive development practically to a standstill, while it increased the cost of everything entering into locomotive construction, maintenance and operation. The result is obvious. Locomotives are paying about one-half the dividends they did before the war; in other words, the cost of tractive effort has been doubled. These costs are not coming down and the railroad security holder will not be satisfied with a lower return. The efficiency of the locomotive must and will be increased to meet the situation.

For years the Germans applied feedwater heaters, while French and English locomotives were somewhat of a curiosity to us because of their light reciprocating parts. More recently pulverized coal has been used on Brazilian locomotives. In pre-war years the American locomotive development was so rapid that the railroads were satisfied to "let well enough alone" and ignored the refinements introduced abroad because costs, particularly fuel cost, were so much lower in this country. Now that cheap coal is a thing of the past there can be no argument against the feedwater heater, lighter reciprocating parts and the use of inferior coals in pulverized form.

Will the railroads utilize the 15 to 20 per cent saving resulting from the use of a feedwater heater and take advantage of alloy steels, not only to reduce dynamic augment but to lighten the weight of reciprocating parts so that boiler capacity can be increased? Will they take the initiative in the development of the use of pulverized coal as a means of utilizing anthracite culm and Dakota lignite? Or will the railroads continue to view these developments from a critical standpoint? Is is easy to say that the feedwater heater will add to maintenance, that alloy steels increase the first cost of the locomotive and that pulverized coal is entirely a development for the future, but it is imperative that mechanical men make these developments a success rather than an obstruction. The motive power department has a better opportunity today than ever before to improve locomotive efficiency.

Wet Steam Decreases Efficiency

In large modern locomotives the boiler often extends up nearly to the limit of the road clearance and the height of the steam dome is greatly restricted. This in turn necessitates placing the throttle valve relatively close to the normal water level in the boiler, and as a result there is a tendency for water to be entrained in the steam at high rates of evaporation or when the water is carried too high. This carying over of water takes place even with the best water supply and is of course aggravated when the water carries impurities that cause foaming or priming. Tests made under both laboratory and road conditions have shown that the steam entering the dry pipe may have as high as four to six per cent of moisture.

If moisture is carried over with the steam the superheater must evaporate the entrained moisture and the superheat is therefore reduced. The amount of heat required to evaporate water is relatively high when compared with the heat

needed to superheat steam; therefore even a small percentage of moisture will cause a serious reduction in the superheat. To convert one pound of water at 200 lb. pressure into steam requires 838 B.t.u., but only 60 B.t.u. are needed to superheat the steam 100 deg. F. Therefore, an increase of five per cent in the moisture content will cause a decrease of 70 deg. in the superheat, assuming that the rate of heat transfer through the tubes is unchanged. If evaporation takes place in the superheater to any considerable extent the unit tubes become lined with scale, thus reducing the rate of heat transfer and cutting down the superheat under all conditions. The serious results of a high moisture content in the steam can be realized from the fact that a falling off in the superheat from 250 deg. to 180 deg. (equivalent to an increase of five per cent in the moisture in the steam) raises the coal consumed about 15 per cent. In other words, each increase of one per cent in the moisture content of the steam will cause a three per cent increase in the fuel consumption.

The loss of efficiency resulting from the entraining of moisture is so serious that the problem of overcoming this trouble deserves careful study. If the dome does not extend up to the clearance limits, the quality of the steam may be improved by making it higher and raising the inlet to the throttle. Locating the dome some distance ahead of the rear tube sheet should be an advantage as the ebulition is least rapid over the forward part of the tubes. Throttle valves which draw steam only from the extreme upper part of the stand pipe are also advantageous. If with the best arrangement of dome and throttle that can be devised the moisture content of the steam is still high, a steam separator may be needed. Plans are now under way for the installation of a steam separator and its effect on the quality of steam will be watched with interest. The fact that an increase of one per cent moisture in the steam will cause an increase of three per cent in fuel consumption is of sufficient importance to warrant the most serious consideration of this problem.

What Do You Think?

In what way do you believe that locomotive efficiency and capacity can be most effectively increased? In this issue Mr. Milner has suggested three or four ways in which he thinks this can be done. If you don't agree with him or can suggest a better means, the *Railway Mechanical Engineer* would like to know your views.

The article on new electric passenger locomotives for the St. Paul indicates very clearly that electrical engineers have not come to any agreement on the best type for passenger service on mountain grades. If you are keeping in touch with electrical matters, as you should, you may be able to give us your own idea as to the best type.

Determining the proper loads for locomotives is a live topic. Mr. Mounce's article will add something to your knowledge of this subject, and if you have a theory on train loading, now is the time to put it into an article.

Freight car repair methods vary the country over. This issue describes in a very complete article how the work is done on the E. P. & S. W. If you cannot tell us how you are repairing cars on your railroad, perhaps you can send the *Railway Mechanical Engineer* some good pictures and a few notes that will tell the story.

In the Shop Practice Section the article on measurement records outlines a method that might be useful in your shop. What do you think about it?

The New Devices Section should not be overlooked if you want to keep up to date.

The *Railway Mechanical Engineer* solicits co-operation on the part of its readers; don't be satisfied with subscribing but contribute something.

NEW BOOKS

The Condensed Chemical Dictionary. 523 pages, 6 in. by 9 in., bound in cloth. Published by the Chemical Catalog Company, 1 Madison avenue, New York.

In the shipment of chemical products, railroads are often confronted with the perplexing problem of determining whether the nature of the chemical makes its transportation hazardous. Realizing the need for a work that would give in a condensed non-technical form information regarding the properties of chemicals, the publishers have compiled this reference work. In addition to a concise statement of the physical and chemical properties commonly included in more voluminous works, there is stated for each substance the type of container used, the fire hazard and the railroad shipping regulations. While the book will be found particularly useful for those who desire data in a non-technical form, it should also prove a handy reference work for chemists.

Mechanical World Year Book for 1920. 328 pages, 4 in. by 6 in., illustrated, bound in cloth. Published by Emmott & Co., Ltd., 65 King street, Manchester, England.

This is the latest edition of an English reference book that has been in publication for 33 years. The current edition is an enlargement over previous issues and contains several new features, including an important section dealing with water and hydraulic work in which information is given on the friction of water in pipes and on pumps and pump fittings. The applications of hydraulic power are described and data given on hydraulic accumulators, hydraulic press cylinders, flanging presses, punching presses, hydraulic pipes and flanges. Another addition is a section on heating and evaporating liquids. This includes descriptions of tubular heaters, feedwater heaters and evaporators. The book is quite complete with respect to gas and oil engines, particularly the Diesel engines.

Inventions, Their Purchase and Sale. By William E. Baff. 230 pages, 5 in. by 7½ in., bound in cloth. Published by D. Van Nostrand, New York.

This book is written by a patent attorney who is familiar with the steps by which many inventors have turned their patents to good account and contains many commonsense suggestions on how to make the most out of an invention after the patent has been obtained. It is essentially a business man's book on the marketing of inventions and does not deal directly with inventions in their inception and handling through the patent office, but rather with the methods of obtaining the greatest return

Invention has played an important part in railroad development and patents developed in railway practice are usually taken in hand by some carrier for the privilege of using the device if it proves successful in operation. If the inventor obtains a broad patent upon a meritorious device he is usually successful in placing it in the hands of an established supply house and does not find it necessary to engage in the business of marketing his invention in order to realize a profit from it. However, no inventor can afford to overlook the business viewpoint. No matter how ingenious his invention may be, it must be something upon which business men can make a profit. This book will recommend itself to any inventor who is anxious to know what is required of a patent to make it successful from a commercial as well as a mechanical standpoint.

COMMUNICATIONS

ABUSE OF SAFETY APPLIANCES

Cincinnati, Ohio.

To the Editor:

There has been a great deal said and written about the inspection and maintenance of safety appliances, but there is very little said about the abuse of them. This abuse is principally due to rough handling or carelessness on the part of trainmen. It is a common occurrence to find several cars on repair tracks daily with ends broken out, causing loose side and end grab irons, or bent and inoperative brake staffs, or uncoupling levers.

Often couplers are pulled out of cars, which are then switched from one track to another, damaging the safety appliances on every car they come in contact with, which could be avoided if the cars were properly disposed of after being damaged.

Safety appliances were made for the protection of trainmen, but as a rule they receive very little consideration, as these employees apparently have little respect for safety appliances or any other part of a freight car. E. F. C.

THE MECHANICS' VIEWPOINT

Meadville, Pa.

To the Editor:

A workman is a funny animal, and to handle him requires tact, diplomacy and a working knowledge of human nature; like a mule he can be led but not driven, and a little appreciation goes a long way to help the monotony of his daily grind, for such it gets to be. Never lose sight of the fact that a man is attracted to the particular work he chooses more by inclination than by circumstances. He follows a bent, a leaning. The way to get the best from him is to *keep him interested*.

This can be done in various ways — by showing a little interest in him and his work, by indirect suggestion, by creating a little friendly rivalry, by an efficient first-aid chest, by fair compensation and by real appreciation. Some men handle their workmen on the theory that they will be impressed and produce more if they, the big men, keep away—hold themselves aloof. Get acquainted with your men, place them to the best advantage, take a healthy interest in their work and the little troubles they have with their jobs and machines, and you will get results.

The last hundred years have shown more advancement than all the years gone before. To be up to date requires more application and study as the times progress; the day of the all-around man has given way to the specialist. The field has broadened to such an extent that he who covers it all knows very little of any one thing, and is constantly running afoul of unseen situations that are easy to foresee and be met by the one on the ground, so to speak. Knowledge commands respect in the shop as in other walks of life, and is a result-getter—one of the best, one that will endure.

You would be surprised if I told you I never saw a man on any kind of a job that was not pleased at the prospect of increased production through the medium of better tools, improved methods, or short cuts. It is a fact, and instead of holding down the output, as he is sometimes accused, he really hopes in some way, not always clear to him perhaps, to increase his daily average; when he does, a little hearty interest repays him and spurs him to greater efforts.

One of the hardest things for man today is to be broadminded, to look without prejudice at the two sides of a question. Some reasons that make it harder are knowledge of only one side of the question, not being interested in two sides, dwelling on theories at the expense of the practical, aloofness and selfishness.

When the big man comes late to work fresh from his daily bath, things naturally look different to him. He goes about his side of it left handed; his comfortable ideas of his own greatness make it hard for him to come down to common everyday problems and explains the breach between him and his men. If the average big man was to obtain the private opinion of his men he would be surprised; he would find the workman's ability to absorb punishment had in no way dulled his sensibilities and the high standard of living of the American worker puts him in a class alone; he must be considered and handled differently than alien labor.

Never advocate piecework as it is the surest way to get indifferent quality and, of course, larger quantity, as quantity is all the pieceworker can see; it is hard on the nerves of the nation and in due time will show its effects. There are other ways to get results, and the dawn is open for them.

From a Railroad Mechanic.

[This letter was not written for publication, but is taken from a personal letter to one of the members of our staff. It is so much to the point that we felt it would be of interest and help to many of our readers in directing the efforts of the men under them.—Editor.]

LUBRICATION OF CYLINDERS

Chicago, Ill.

To the Editor:

In your editorial on "Lubrication of Cylinders," in the March issue, you call attention to the various points at which the oil is injected, but say nothing about the manner of delivery. It stands to reason that with the gravity lubricator, the lower the point at which the oil is injected into the steam the more regular the delivery will be. Connecting the gravity feed lubricator pipe to the cylinder instead of in the steam pipe has the additional advantage of delivering the oil into steam of less pressure. These two factors, the greater pressure head and the reduced resistance pressure, should tend toward an improved cylinder lubrication, provided carbon incrustation can be avoided.

I cannot, however, see how the valve lubrication would be improved, since it is conceded by those who advocate gravity lubricators feeding into the cylinder only, that the live steam valve rings would have to depend for lubrication on the oil that is carried by the exhaust rings of the valve to that part of the valve chamber wall traveled by the live steam rings.

You also state that there is a growing tendency to dispense with swabs on piston rods. The reason you give, however, is not the whole cause. The principal reason is that the rod packing cannot pack against a thin film of oil so that with pressure inside the cylinder and no pressure outside, enough oil impregnated steam leaks by the packing to lubricate the rod.

If the above holds true we should not expect good lubrication of the live steam valve rings, because the conditions are just the reverse of rod lubrication. In the rod lubrication the pressure side carries the oil to the non-pressure side, which is natural, while with the valve lubrication we should not expect the lower exhaust pressure side to carry and maintain the oil in the higher live steam pressure side.

It seems reasonable, therefore, to lubricate the live steam side of the valve first, by injecting the oil into the steam pipe about 20 in. above the valve, and with the same oil impregnated steam, lubricate the cylinder and, again, as an extra precaution that does not cost anything, use that same oil impregnated steam to lubricate the exhaust side of the valve. It is absolutely necessary, to realize the best results from the scheme above outlined, to inject the oil into the steam at every revolution of the drivers, as can be done with a force feed lubricator. W. J. Schlacks.

St. Paul Passenger with General Electric Locomotive

New Electric Locomotives for the C. M. & St. P

Description of Two Radically Different Types Recently Designed for Passenger Service

FIFTEEN additional electric passenger locomotives are now being constructed for the electrified divisions of the Chicago, Milwaukee & St. Paul. Five of these are being built by the General Electric Company and ten by the Westinghouse Electric & Manufacturing Company in conjunction with the Baldwin Locomotive Works.

The motive power equipment for the initial electrified division of 440 miles over the Rocky Mountains consisted of 32 freight locomotives, 10 passenger locomotives and 4 switching locomotives. When it was decided to electrify the division over the Cascade Mountains these 15 new passenger locomotives were ordered. The original 10 passenger locomotives will be regeared for freight service, so that the St. Paul will now have 15 passenger, 42 freight and 4 switchers, or a total of 61 electric locomotives in service on the two electrified divisions.

The two new types of electric passenger locomotives built for the Chicago, Milwaukee & St. Paul were designed for the same class of service by different groups of engineers working independently; from an inspection of the finished locomotives it would appear that the two types could hardly be more different.

Roughly the requirements for both designs were as follows: The locomotives must collect 3,000 volt direct current power from an overhead catenary. They must be able to haul a 12-car passenger train weighing 950 tons over a two per cent grade, compensated for a distance of 20 miles, and over a 2.2 per cent grade compensated for a distance of 17.8 miles. They must maintain speeds of approximately 25 miles an hour up two per cent grades, 35 miles an hour up one per cent grades, 60 miles an hour on level tangent track and must hold trains on down grades by regenerative braking at speeds consistent with safe operation. The sharpest curve on the main line is 10 deg., but the specifications required that the locomotives must negotiate a 16-deg. curve in the yards satisfactorily.

The General Electric Locomotive

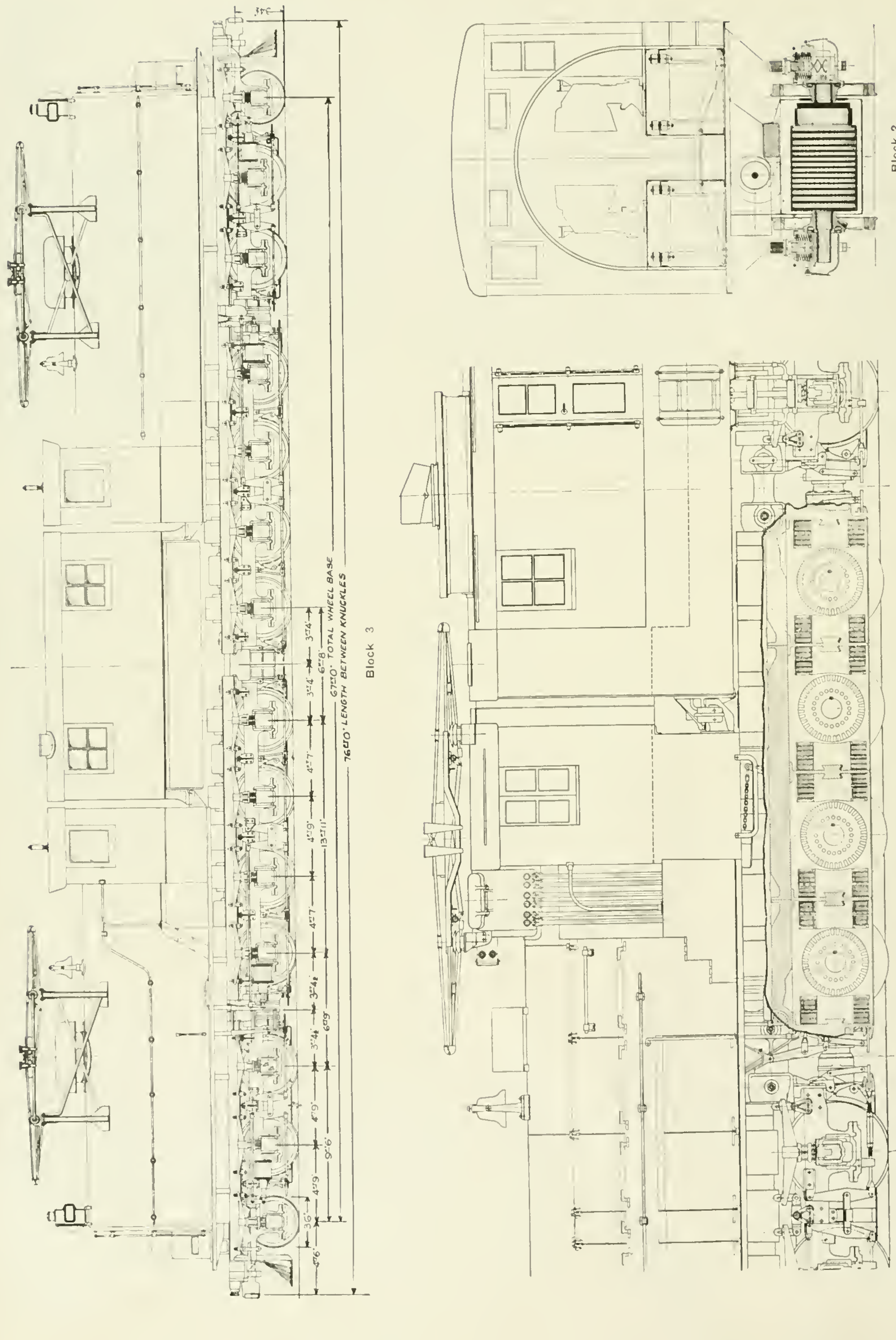
The running gear of the General Electric locomotive is composed of four individual trucks, two end trucks having three axles each, and two center trucks having four axles each. These trucks are connected together by special articulation joints. The motor armatures are mounted on the axles and the motor fields are carried on the truck frames.

The two end sections are similar to each other in appearance. The operator's cab in either section is on the inner end next to the heater cab above described, in order that the operator can be convenient to the heater and in order to allow a maximum space for apparatus in the apparatus cab or outer end section. Another advantage of this arrangement of cabs is that the operator can have access to any section of the locomotive requiring his presence without passing through a section containing high-tension apparatus. The engineer's or operating cab contains a main or master controller, the air brake valves and handles, and an instrument panel, containing air gages, ammeters, and speed indicator. The engineer uses either of the two operating cabs according to the direction in which he is running.

A door gives access from the operating cab to the apparatus section which extends with a cylindrical top to the extreme end of the locomotive. The cylindrical construction naturally adapts itself to the protection of the apparatus included and in addition to this it has the advantage of allowing a clear vision for the operator from his normal operating position.

Motors

The motors are of the bi-polar gearless design which were adopted by the New York Central 14 years ago for operating



Side Elevation and Section of General Electric Locomotive, Showing Wheel Arrangement and Location of Motors

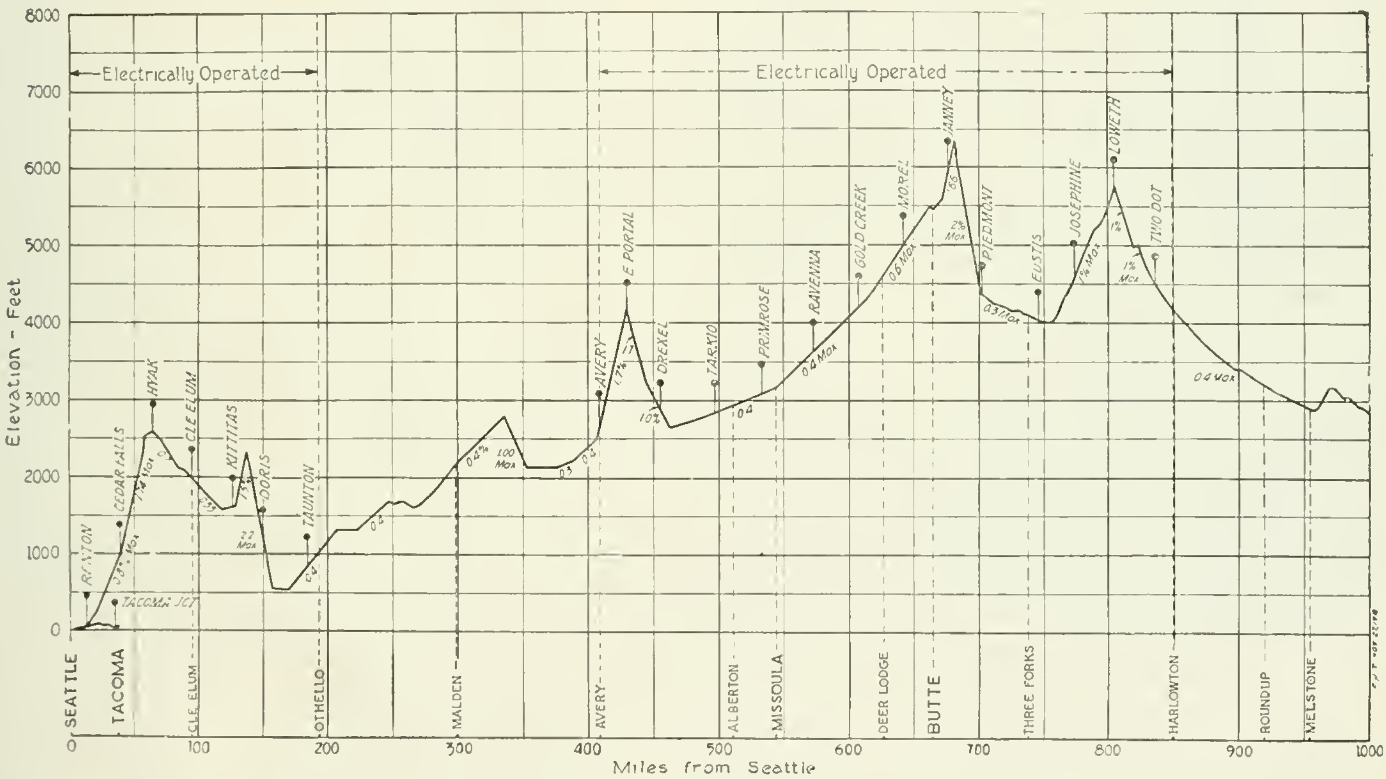
heavy passenger trains between Grand Central Station and Harmon, N. Y. To insure light weight per axle, flexibility in control, good truck arrangement for curving as well as for high-speed running, twelve motors are chosen, each of relatively small capacity. They are especially designed to withstand high temperature, being insulated with mica and asbestos. The continuous rating of each motor at 1,000 volts and with 120 deg. rise by resistance is 266 hp., corresponding to 3,500 tractive effort at the rim of the drivers at a speed of 28.4 mi. per hr. Forced ventilation is employed for cooling. The armature core is provided with holes for the passage of ventilating air. Ventilating blowers are located above each motor armature and deliver air at the commutator end of the motor where it divides, a part passing through the armature and a part back through and around the field coils where it escapes upwards and is afterwards used for ventilating the starting resistors.

This type of motor lends itself nicely to simple and compact locomotive design as the frame is made use of to furnish the entire path for the magnetic flux. The pole pieces in series across 3,000 volts. The second combination has six rheostatic steps, one full field step, and one tapped field step, with six motors in series and two sets in multiple. The third combination has eight rheostatic steps, one full field step, and one tapped field step, with four motors in series, and three sets in multiple. The fourth combination has eight rheostatic steps, one full field step, and one tapped field step, with three motors in series, and four sets in multiple. This results in a total of 39 control steps with a choice of eight operating speeds, exclusive of the resistance steps.

The regeneration of power for braking is accomplished by using some of the motors for exciting the fields of the others, which in turn are used as generators to return power to the line.

Auxiliary Apparatus

The center cab is occupied by an oil-fired steam boiler for heating passenger trains and with accessories, including tanks for oil and water, circulating pumps, and a motor-driven blower for furnishing forced draft. This center portion of



Profile Showing the Two Electrified Divisions of the Chicago, Milwaukee & St. Paul

and field coils are fastened to the cross transoms of the trucks and the magnetic flux passes horizontally in series through all twelve motors, finding a return path through the locomotive frame. The articulation joints between the trucks are made in such a manner that large surfaces are in contact to provide an easy path for the flux. The pole pieces are made flat in order to prevent the pole pieces from coming in contact with the armature during the vertical movement of the truck frame on its springs or when removing or assembling the armatures. A minimum clearance of ⅛-in. on each side is allowed between the armature and the pole piece tips. The brushholders are bolted to the transom allowing the brushes to move up and down with the fields as the frame rides on the truck springs.

Control

The control for motoring is arranged for four motor combinations. The first combination has nine rheostatic steps, one full field step, and one tapped field step, with twelve motors

the cab may be lifted out in case the steam boiler is in need of heavy repairs.

Power for train lighting is obtained from the motor-generator set. A switchboard located in the operator's section of one of the cabs is equipped with switches, resistors and meters for controlling the train lighting circuit. The head end system of lighting is in use on the trains over this division. In the other operating cab is a small motor-driven air compressor, operated from the battery circuit, with sufficient capacity for raising the pantograph when first putting the locomotive in operation.

A slider pantograph, similar in construction to those now in use, is mounted on each of the operating cabs. This pantograph has two sliding contacts, giving a total of four on the slider with a double trolley. The pantograph and flexible twin trolley construction enable the locomotive to collect current as high as 2,000 amperes at speeds up to 60 miles an hour without noticeable arcing at the contact points. The second pantograph is held in reserve as a spare. Sand boxes,

with pipes leading to each pair of driving wheels, are located directly beneath the pantographs outside of the operating cab.

Mechanical Construction

To soften any lateral blow that may be given against the rail head, the leading and trailing axles are allowed a movement of one-half inch relative to the truck frame, either way from their central position. This movement takes place against a resistance introduced by wedges above the journal boxes which tend to hold the box in its central position and to give a dead beat action opposing the motion. To further protect the track from lateral displacement on the ties, the outer end of the superstructure is carried on rollers, bearing on inclined planes upon the truck frames, while the inner end of the superstructure is rigidly bolted to one of the middle trucks. This construction tends to hold the leading and trailing trucks in their central position.

View from Engineer's Position on General Electric Locomotive

When a blow is delivered by the leading or trailing truck against the rail head, the superstructure, which is rigidly bolted to the middle truck, is displaced laterally across the outer truck very much as a boiler of a Mallet locomotive swings across its leading truck. In such a sideways displacement, the weight of the superstructure rolls up on the inclined plane on that side and thus transfers weight to the rail that is affected, thereby increasing the adhesion of the rail to the tie. This action really has two results. It not only increases the holding power between rail and tie at that point, but it introduces a time lag and increases the time and distance during which the pressure is delivered to the rail head.

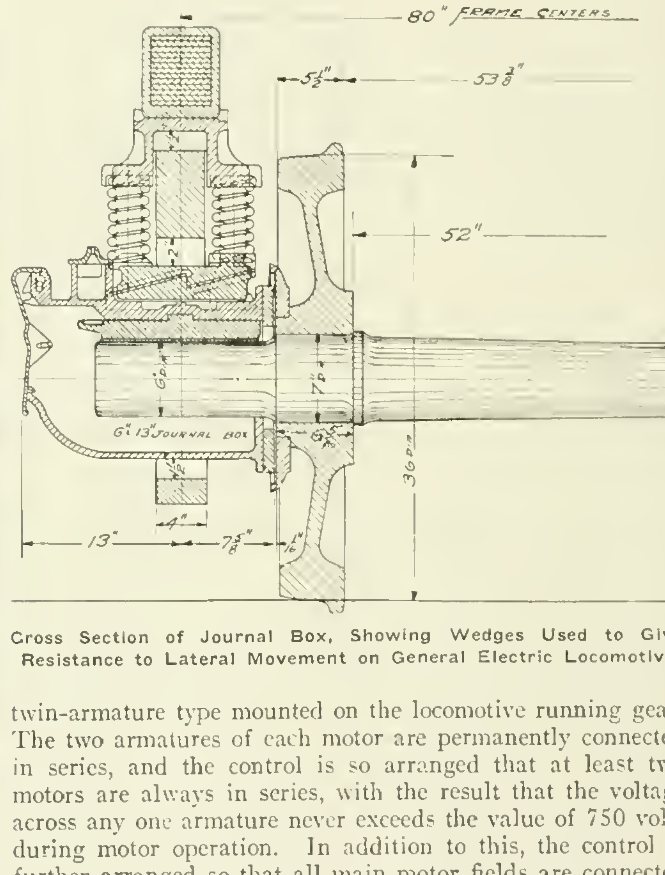
The Baldwin-Westinghouse Locomotive

The locomotive consists of two duplicate running gears of the Pacific type, placed back to back, supporting a single cab. The wheel arrangement of the locomotive is 4-6-2-2-6-4, with 68-in. drivers, a rigid wheel base of 16 ft. 9 in. and a total wheel base of 79 ft. 10 in. Rigid and floating center pins have been provided to relieve the cab structure of pulling and bumping strains, all such forces being transmitted directly through the running gear.

The articulation of the various trucks was considered one of the most important points of design. It was the endeavor to have each truck laid down so that each one would take care of itself and would not have to be led along by any of its companion trucks. During a series of tests made at East Pittsburgh, Pa., this feature of the mechanical operation of the locomotive was pronounced and the locomotive was declared to have especially good riding qualities. An extensive study was also made of weight distribution and its equalization between trucks. With this latter end in view, comparatively long spring hangers have been used so that any slight increase or decrease in their length for the purpose of shifting the load does not have any noticeable effect on the position of the locomotive springs.

Motors

The 3,000-volt direct current power is conducted through the necessary switches and resistances to six motors of the

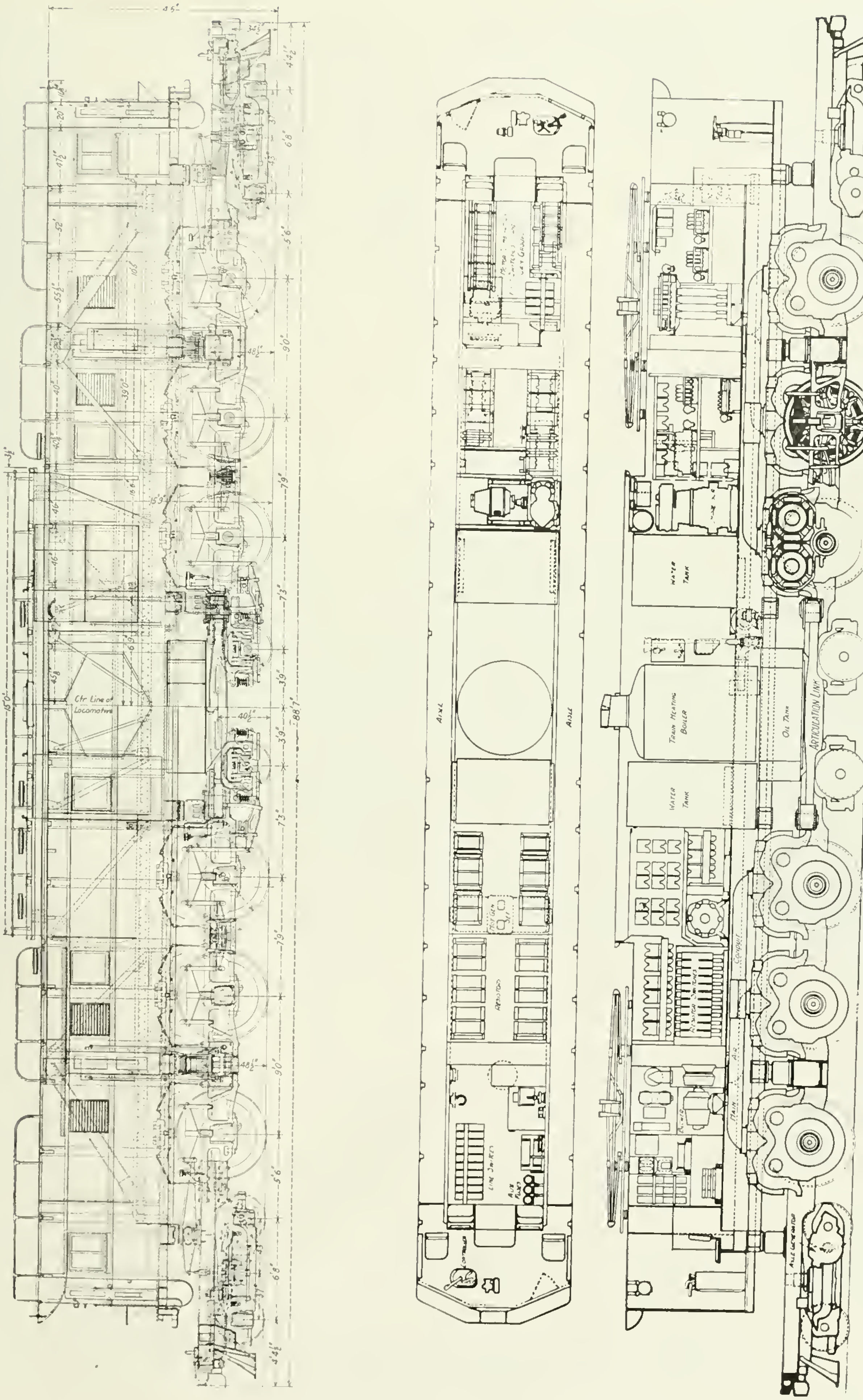


Cross Section of Journal Box, Showing Wedges Used to Give Resistance to Lateral Movement on General Electric Locomotive

twin-armature type mounted on the locomotive running gear. The two armatures of each motor are permanently connected in series, and the control is so arranged that at least two motors are always in series, with the result that the voltage across any one armature never exceeds the value of 750 volts during motor operation. In addition to this, the control is further arranged so that all main motor fields are connected on the grounded side of the circuit, thus maintaining most of the voltage stresses on the motors practically in line with commercial usage for the past 15 or 20 years.

One motor is mounted over each driving axle on the frame of the locomotive, and power from each armature is transmitted by pinions to a gear with an 89:24 reduction. The gear is mounted on a quill shaft, which is also supported on the locomotive frame, and which surrounds the locomotive axle with an appreciable clearance. The connection between the driving wheel and the quill shaft is made by springs. One end of each spring is connected to the quill shaft, while the other engages a bracket on the spoke of the driving wheel.

This arrangement permits the driving wheels to follow the unevenness of the roadbed, without affecting gear mesh, as well as cushioning the torque of the motor. In the design of this type of quill shaft the details have been governed by the experience obtained from the successful application of a similar type of drive on the New York, New Haven & Hartford locomotives, making due allowance for the increase in tractive effort.



Side Elevation and Plan and Section of Baldwin-Westinghouse Locomotive, Showing General Arrangement of Apparatus

The manner of regenerating power for operation on down grades used on these locomotives embodies features which have not been used before. The main driving motors are series motors, and in order to make them regenerate power to the line it is necessary that they be separately excited. The control of the excitation of the main motors for regeneration is initiated manually by the operator from the master controller, the exciting current coming from two small generators geared to one of the axles of each bogie truck. These small generators in turn are excited from an independent source, consisting of a motor-generator set operating in parallel with a small storage battery. All of the main motors are used during regeneration. Efforts have been made in the design of main motors and the axle generators to guard against any possibility of snow getting into the windings. One of the axle generators is mounted on each bogie truck in a standard street railway motor frame.

Control

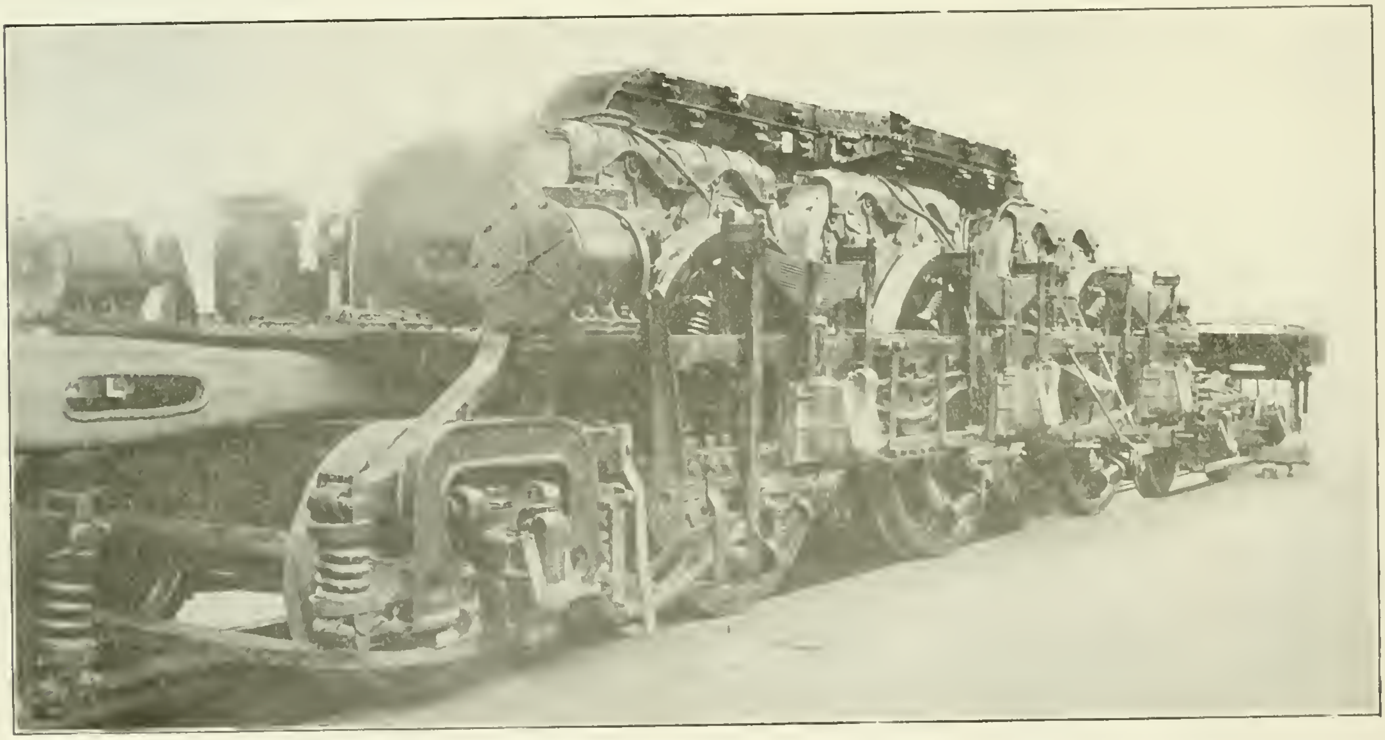
The locomotive control provides three motor combinations, giving one full series and two series-parallel connections. The two latter connections consist of two parallel circuits of three motors in series and three parallel circuits with four motors in series. In each of these motor combinations three running notches are provided, which are full field, short shunt and long shunt. This provides a total of nine running speeds without resistance connected in the circuits.

While descending a grade the excitation of the motor field is entirely under the control of the engineman and may be increased or decreased as desired, causing corresponding increments and decrements to the regenerative effort of the locomotive, thus varying the speed of the train through any desired range. The full motor capacity of the locomotive is available for regeneration, and under all conditions of grade on which it will be used it should be able to handle any train down grade that would require double-heading on the way up.

Auxiliary Apparatus

Power for energizing the control circuit and operating the auxiliary apparatus, a small blower motor, the motor-driven air compressor, etc., when these are not being driven by the axle generator, is obtained from a small motor generator set and storage battery which are used to excite the fields of the axle generators. The high-tension winding of this set is the only piece of revolving apparatus in a locomotive, with the exception of the main motors, which is connected to the 3,000-volt circuit. The low-tension side of the motor generator set is provided with slip rings for the generation of a low voltage alternating current for the headlight and for some of the interior cab lights. During motoring and when coasting without regeneration, the axle generators are automatically connected to the low voltage auxiliary circuit, so that the motor generator for the greater part of the time is only necessary for furnishing excitation to the axle generator field and for charging the storage battery. This reduces the necessary size of the motor generator set.

The center compartment of the locomotive is given up entirely to an oil-fired steam boiler, its supply tank and auxiliaries. This boiler supplies steam for heating trains and is capable of evaporating 4,000 lb. of water per hour. Two storage tanks for water are provided, having a combined capacity of 25,500 lb. of water. There is also a tank for the fuel oil, with a capacity of 750 gallons. The boiler also feeds radiators located in each of the operating cabs.



Running Gear of One Half of the Baldwin-Westinghouse Locomotive With Motors in Place

Comparative Data for the Two Locomotives

	General Electric	Westinghouse
Total weight	521,200 lb.	550,000 lb.
Total weight on drivers	457,680 lb.	336,000 lb.
Non-spring-borne weight per driving axle	9,500 lb.	7,800 lb.
Length over-all	76 ft. 0 in.	88 ft. 7 in.
Height over cabs	14 ft. 11⅝ in.	14 ft. 6 in.
Height over pantograph, locked down	16 ft. 8 in.	16 ft. 7⅞ in.
Total wheelbase	67 ft. 0 in.	79 ft. 10 in.
Maximum rigid wheelbase	13 ft. 9 in.	16 ft. 9 in.
Diameter of driving wheels	44 in.	68 in.
Diameter of idle wheels	36 in.	36 in.
Heater capacity	4,000 lb. steam. per hr.	4,000 lb.
Water capacity	30,000 lb.	25,500 lb.
Oil capacity	6,000 lb.	750 gal.
Compressor capacity	150 cu. ft. per min.	150 cu. ft. per min.
Number of motors	12	12
Type of motor	(Bi-polar) GE-100	(Twin) 4-pole

Locomotive rating:	General Electric Tapped field	General Electric Full field	Westinghouse
Total horsepower, one-hour motor rating	3,480	3,380	4,200
Total tractive effort one-hour motor rating	36,000	46,000	66,000
Speed, miles per bour	36.2	27.5	23.8
Total borsepower continuous	3,200	3,200	3,360

Increasing Locomotive Efficiency and Capacity*

Improvements Suggested Include Feedwater Heating, Trailer Booster, Lighter Rods and Cut-off Regulation

By B. B. MILNER
Engineer of Motive Power and Rolling Stock, New York Central

IN discussing methods of increasing the efficiency and operating capacity of steam locomotives, I shall pass over the well worked questions of maintenance, fuel, feedwater, feedwater treatment, lubrication, stokers and the whole unlimited question of locomotive design by confining my remarks to a very few operating efficiency and capacity increasing adjuncts which I believe important because susceptible of profitable application to existing power.

Feedwater Heaters

First, I shall suggest one locomotive accessory, which in my judgment stands out with surpassing and immediate importance, viz.: the feedwater heater, an instrument by means of which a portion of the heat ordinarily rejected at the stack of a locomotive may be conserved and used by abstracting this heat from either the smokebox gases or the exhaust steam, and using it for the preheating of feedwater. Thus far the heat source of the more successful schemes for thus conserving the ordinarily rejected energy has been the exhaust steam. These schemes involve replacement of the injector. The injector is a 100 per cent instrument from the standpoint of returning to the boiler all of the heat energy delivered to it from the boiler in the form of operating or driving steam, and it does most efficiently take feedwater at ordinary temperatures and deliver it to the boiler. The energy of the steam supply is divided between elevating the feedwater temperature and imparting to it the kinetic energy necessary to drive it into the boiler, and there is practically no heat lost. Against this arrangement, a saving must be represented in elevating the temperature of the feedwater by the use, not of heat drawn from the boiler, but of heat otherwise rejected at the stack, provided, of course, that the energy consumed by the mechanical operation of the feedwater heating means does not approach closely the quantity of heat caught and used instead of being rejected. A number of such means are now currently and regularly raising the ordinary temperature of locomotive feedwater—say, from 62 deg. F. to approximately 212 deg. F., or through a range of 150 deg. F.

Twenty or more years ago, the late M. N. Forney introduced a paper on the feedwater heater with the following statement: "To convert one pound of water of zero temperature into steam of 200 lb. pressure requires 1231.7 units of heat: a unit being the amount required to raise one pound of water one degree. If the average temperature of water in a locomotive tender is 60 deg., then 1231.7 — 60 = 1171.7 units of heat must be imparted to it to convert it into steam of the pressure named. One per cent of that will be 11.71 units, so that if each pound of feedwater is increased that many—or say 12 deg. in temperature, by waste heat, before it enters the boiler, it will be equivalent to a saving of one per cent of the fuel required to convert it into steam. This is true theoretically and has often been proved practically." Therefore, a locomotive feedwater heater which raises the temperature of feedwater through 150 deg. F., gives a fuel saving of over 12 per cent—a considerable margin of saving upon which to work.

It therefore appears that the problem of successful feedwater heating by means of exhaust steam should not involve any elaborate tests, particularly directed to the ever difficult weight and work measurement of fuel economy, but may and should be properly restricted to the mechanical performance of the feedwater heating instrument, the reduction in the cost of its maintenance and the development of assured continuity of service. We are dealing with such a large actual economy that the carriers may well afford the expenditures involved in the contribution to more definitely establishing the solution of the mechanical problem involved, without any particular concern for the question of what may be the thermal results upon which actual savings in fuel consumption must necessarily be based; that is, they may well afford active contribution to the working out of whatever mechanical difficulties may yet have to be met by the application and use of feedwater heater equipment now available or hereafter developed for locomotive service.

The above has been addressed particularly to the question of efficiency or economy. The question of capacity is also favorably affected in that not only is heat reclaimed from the exhaust and used, but the condensed steam as well. And to the extent that condensation is so reclaimed, it is returned to the boiler, thereby reducing the quantity of water which must be supplied to the locomotive tender for covering a given amount of work. The quantity of steam reclaimed from the exhaust figures about 15 per cent. This means that a locomotive tender of given capacity will cover an amount of work that much greater; that either the work per unit of time may be correspondingly increased or, if this work remains constant, it may be continued for a correspondingly greater distance or time. Every pound of steam reclaimed from the exhaust reduces by that amount the weight of tank water which must be evaporated.

Trailer Booster

There has been recently developed what has come to be known as a "booster," consisting of an ordinary reciprocating steam engine geared to the locomotive trailer wheels, designed for use as may be required in the starting of trains, getting them to speed the more promptly, or both, by adding to the tractive efforts ordinarily developed at the lower speeds.

The operation of this booster is controlled by air pressure. At the front end of the reverse lever quadrant is provided a manually operated latch, by means of which the booster is made "normally" inoperative or operative when the reverse lever is in the extreme forward position. With this latch in the operative position, the reverse lever, when pushed "into the corner" engages an air valve which permits air pressure to pass from the main reservoir to the booster clutch cylinder, and thence to what has come to be known as the pilot valve, mounted back of the boiler dome. When the main throttle is opened, a supply of steam from the dry pipe to this pilot valve causes it to permit air pressure from the booster clutch cylinder to open the booster throttle valve. When the reverse lever is pulled "from the corner" or the latch at the front end of the reverse lever quadrant is 'thrown out," the booster's steam supply is cut off and the booster clutch immediately disengaged. The apparatus is, therefore, protected against damage from broken pipes, lack of air, or damage from other possible cause. When the booster is not in use, it is "out of gear" and idle, none of its parts being in operation, and the performance of the locomotive then being in no way affected by reason of the booster application.

Characteristic drawbar-pull and horsepower-speed curves

*From a paper presented before the New York Railroad Club, April 16, 1920.

taken from dynamometer car data are shown by Fig. 1, from which it will be noted that the initial drawbar-pull is, by use of the booster, increased from some 37,000 lb. to 47,000 lb., that the increase in drawbar-pull and the horsepower begins to diminish perceptibly at about 15 miles per hour, and that the booster becomes a load upon the regular locomotive cylinders at speeds approximating 20 miles an hour. Recalling, however, that the booster operation is discontinued by removal of the reverse lever "from the corner," it will be understood that interruption of booster operation is assured for quite some time before having attained even the speed of 15 miles per hour, at which the advantage in the use of the booster begins to appreciably diminish; that is, long before the diminution of this advantage occurs, and much longer before there is any possibility of the booster becoming a load on the main cylinders, the booster will always have been thrown out of gear. Fig. 1 also discloses the wide margin in the ability of the boiler to supply the booster with steam, as has been proven in service, and becomes very apparent by realization of how small are the horsepower outputs from the start up to speeds at which the booster will be thrown out of gear, in comparison with the much larger horsepowers for which locomotive boilers are all amply able to supply the necessary steam.

The booster, as a means of helping existing locomotives

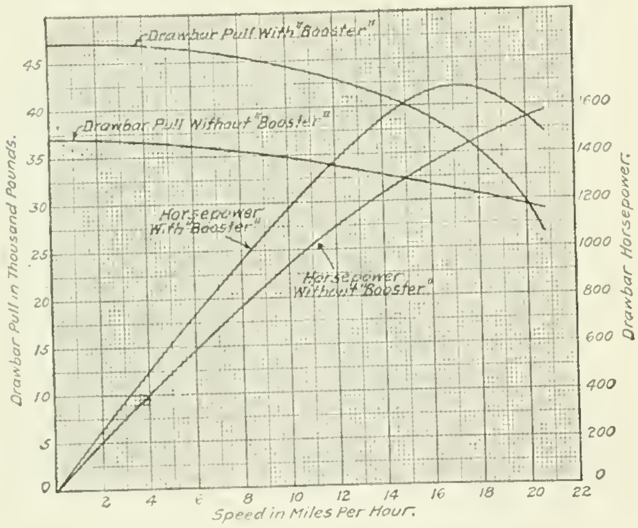


Fig. 1—Drawbar Pull and Horsepower, With and Without Trailer Booster

through work which they are now only able to do with difficulty, if indeed they are able to do at all, will result in the satisfactory handling of larger trains, increased acceleration rates, or both. Increased acceleration should be particularly valuable in frequent-stop passenger service, and the higher initial or starting drawbar pulls and the ability to start heavier trains should be valuable in both freight and passenger services under what are now trying, if not prohibitive, starting conditions. The booster is applicable to most existing trailing wheel locomotives, and should materially increase the efficiency of operation, particularly from the standpoint of the locomotive being a transportation producing instrument.

The curves in Fig. 2, however, show clearly the advantages of the booster use from an acceleration standpoint, the train hauled being one consisting of 2,210 gross tons in 104 cars on a slightly opposing grade. Note, for example, that without the booster the speed of 16 miles an hour was obtained in 450 seconds, while with the booster this speed was obtained in 250 seconds or in nearly 50 per cent less time, amounting to over three minutes. The arrangement will undoubtedly prove a valuable addition to many existing trailing wheel locomotives which have become inadequate to serve needs on account of deficiency in starting capacity, and also valuable for new trailing wheel locomotives in that greater starting power and capacity may be obtained without increasing the boiler, number of driving wheels, or materially increasing weights.

Dynamic Augment

Another way to increase the operating capacity of locomotives is to lighten the reciprocating and revolving weights by the use of alloy steel. This will permit of increasing the

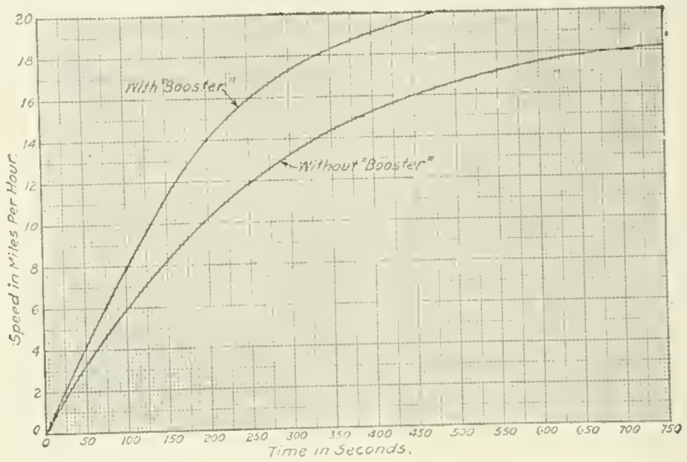


Fig. 2—Curves Showing Increased Acceleration Secured With Booster

weight of the boiler without increasing the rail pressure at speeds. In fact, the rail pressure at speeds may be actually reduced with even heavier boilers by reducing the dynamic augment of the balancing forces. This subject is sufficient for a paper by itself and may be only mentioned here.

Proper Cut-off for Maximum Horse-Power

One of the most important factors in locomotive operation and one to which very little attention has been paid, is the science involved in selecting the proper cut-off or the reverse

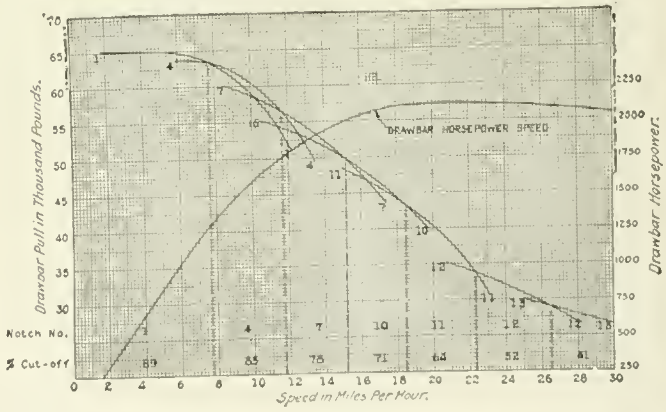


Fig. 3—Composite Drawbar Pull—Speed Curve

lever locations required at various speeds for the development of maximum horsepower or drawbar-pull. Everyone probably knows that for any and each particular speed, there is only one reverse lever position or cut-off at which the locomotive will deliver its maximum in either horse-power or drawbar-pull; that is, if this reverse lever position be notch 07, cut-off 78 per cent, at say, 14 miles per hour, in any other reverse lever position and at any other cut-off, either greater or less, the locomotive will not deliver the maximum at this speed. But how do enginemen actually select vari-

ous reverse lever positions at various speeds, or how have they been taught to select them when maximum horsepower or drawbar-pull output is desired or actually required in order to go through a "tight" situation either on account of the liability of "sticking" or of failing to make satisfactory time. I suggest that to have done so little for enginemen in this connection is, to say the least, somewhat of a reflection. To spend time and money in the arrangement and design of a locomotive, which in these days represents an investment of $60,000 or more, and then turn such an engine over to enginemen to run "catch as catch can," so far as concerns cut-off selection, is not very creditable.

The graphic chart, Fig. 3, shows the general relations existing between speeds and the drawbar-pulls developed by the use of the various constant cut-offs as represented by reverse lever notches, numbered 1, 4, 7, 10, etc., consecutively from the most forward or longest cut-off reverse lever position. In accordance with facts, this chart indicates that initial drawbar-pull at zero speed, or when starting, decreases with decreases in the cut-off used: that is, a longer cut-off will develop a higher initial drawbar-pull, whereas a shorter cut-off will develop a correspondingly lower initial drawbar-pull. This chart also indicates that at successively higher speeds, successively shorter cut-offs develop maximum drawbar-pulls, or in other words, for any speed there exists a definite cut-off at which the drawbar-pulls will be maximum and the selection of any other than the "maximum drawbar-pull cut-off," either higher or lower, will develop a lesser drawbar-pull.

It becomes, therefore, apparent that some knowledge of the precise cut-offs or reverse lever positions, which at various speeds will result in the development of the desired maximum drawbar-pull, must obtain and be used if maximum results are to be secured. What I have said covers the situation in a general way, but there remains the problem of how the necessary cut-off-speed-drawbar-pull data may best be obtained, and having obtained it how use may be made thereof. By inserting a second speed controlling engine between the dynamometer car and the train the drawbar-pulls developed by the first or leading engine ahead of the dynamometer car and under test, may be very esily obtained for all desired speeds. In Fig. 4 are shown the results of four tests made with the same engine and same train on the same day over a ruling grade indicating the advantage of using proper cut-offs.

All of the information, supplemented only by a watch, used in making the fourth and successful run covered by Fig. 4, is shown by Fig. 5, which presents the front and back of conveniently arranged vest pocket cards for the use and information of enginemen. This information is sufficient for them if they be careful, painstaking and understanding, but it must be freely admitted that the very neat selection of cut-offs from this card information cannot be expected or depended upon, because all attention possible may not be enough and enginemen have other matters for their thought and time. It is suggested that the development of automatic means of taking care of this cut-off selection matter remains to be worked out, and there is reason for believing that several mechanical schemes for covering the matter will be developed into practical form, and that, in due course, enginemen will be relieved entirely of attention to reverse levers and cut-off selection, except where less than maximum output is desired, under which conditions the engineman's mind will continue to be required, as at present,

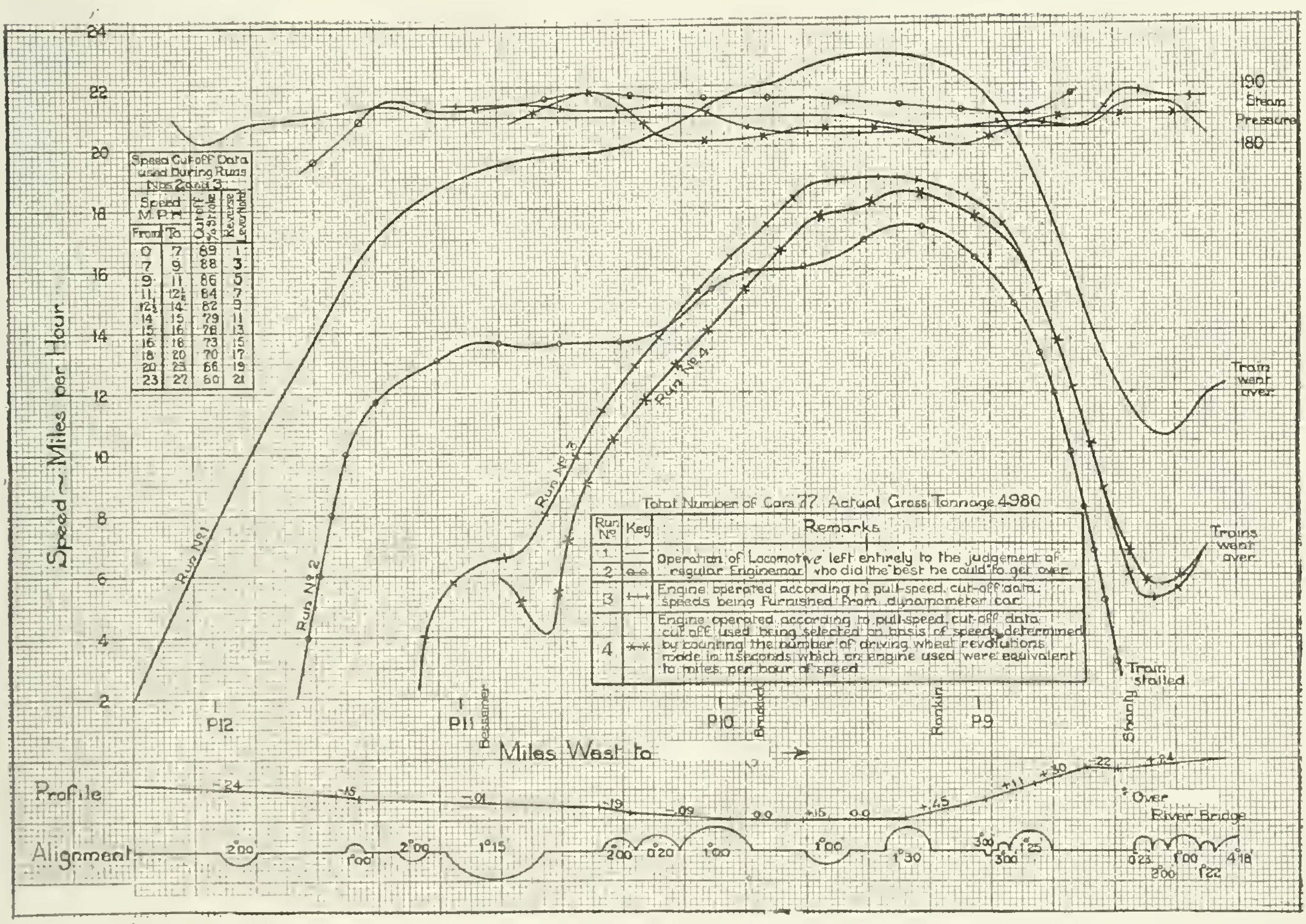


Fig. 4—Graphic Chart of Four Runs, Indicating the Advantage of Using Proper Cut-Off

for following instructions to "use full throttle until the shortest cut-off, meeting the speed and load requirements, or the least at which the engine will run smoothly has been reached and thereafter 'throttle' as necessary to meet speed requirements." Essentially these instructions are exhibited upon the back of the enginemen's card referred to, and shown herein as Fig. 5.

Statement showing reverse lever notches and cut-offs at which maximum drawbar pulls are developed.

RAILROAD October, 1919

Class H-8				Class H-9				Class K-4			
Speed M. P. H. From	To	Cut-off (a)	Rev. Lev. Notch (b)	Speed M. P. H. From	To	Cut-off (a)	Rev. Lev. Notch (b)	Speed M. P. H. From	To	Cut-off (a)	Rev. Wheel R (c)
0	8	89		0	7	89	1	0	9	85	0
8	12	85		7	9	88	3	9	15	82	1
12	15	78		9	11	86	5	15	21	79	2
15	18½	71		11	12½	84	7	21	27	74	3
18½	22	64		12½	14	82	9	27	31	68	4
22	26½	52		14	15	79	11	31	35	66	4¼
26½	30	41		15	16	76	13	35	40	64	4½
				16	18	73	15	40	45	62	4¾
				18	20	70	17	45	50	59	5
				20	23	66	19	50	55	53.5	5½
				23	27	60	21	55	60	46.5	6
								60	65	39	6½

NOTE.

(a) Percent of stroke.

(b) Counting from front end of fine tooth air reverse quadrant, the notch at which specified maximum valve travel is obtained, is No. 1.

(c) Screw reverse wheel revolutions are counted from full forward position (zero) at which specified maximum valve travel is obtained.

GENERAL.

In case quadrants or screw gears are changed new notches or positions may be obtained from cut-offs shown.

(over)

(Front of Card)

USE FULL THROTTLE until the shortest cut-off at which the engine will run smoothly has been reached, then "throttle" as necessary to meet speed requirements.

DIMENSIONS

CLASS	CYLINDERS	DRIVERS
H-8	27"x30"	56"
H-9	27"x32"	63"
K-4	23½"x26"	72"

FOR ASSISTANCE IN ASCERTAINING SPEED

Note that the number of revolutions which engine drivers of the following [illegible] .... Make in the following number of seconds .... Equals the speed of the locomotive in miles per hour	72 / 13	68" / 12	63 / 11.2	62" / 11	56" / 10	50 / 9

over

(Back of Card)

Fig. 5—Data for Guidance of Enginemen in Selecting Cut-Off

Discussion

W. E. Woodward (Lima Locomotive Corporation) referred to a recent comparison of electric and steam locomotives in which the average coal consumption per horsepower-hour for steam locomotives was given at 7.86 lb. The tests on which these data were based were conducted several years ago and the results of more recent road trials showed the comparable figure for modern locomotives to be between 3.4 and 4.0 lb., demonstrating that a considerable increase in efficiency had been effected in the last few years. Mr. Woodward pointed out that a reduction in the dynamic augment is a promising method of increasing the capacity and efficiency of locomotives. The limit of driving wheel loads has now been reached, but there is no reason why the static load cannot be increased if the pressure on the rail at the high speeds developed at present is not exceeded. By reducing the dynamic augment the weight on each pair of driving wheels could be increased 10,000 lb. and this increased weight could be utilized in capacity or efficiency increasing devices. The trailer booster gives a considerable increase in the drawbar pull, with a slight increase in weight and cost, and in Mr. Woodward's opinion represents the most practical method yet devised to utilize the potential boiler capacity of the locomotive at low speeds.

George M. Basford (Locomotive Feedwater Heater Company) referred to the fact that the stability of the railroads depends on whether railroad securities are attractive to the investor, and mentioned the appliances discussed in the paper as means by which the investment in locomotives could be made to bring a higher return. Describing the performance of feedwater heaters Mr. Basford stated that temperatures as high as 250 deg. F. had been obtained with the closed type of heater, effecting a saving of 15 per cent. He called attention to the incidental increase in boiler efficiency resulting from the lower rate of combustion and evaporation, which cause an additional gain of about four per cent. Mr. Basford expressed the opinion that the field for the trailer booster was not confined to freight locomotives, but on passenger power this device would prevent delays and improve operating conditions.

W. D. Wood (Fuller Engineering Company) submitted data to show the possibility of increasing efficiency by the use of pulverized coal. He stated that a mixture of bituminous coal with 38 per cent anthracite silt having a heating value of approximately 11,800 B.t.u. per pound, was developing an actual evaporation of 6.5 to 7 lb., or an equivalent evaporation of approximately 8 lb. per pound of fuel. The over-all efficiency of the boiler burning this pulverized coal ranged from 63 to 70 per cent.

RAILROAD LABOR BOARD APPOINTED

President Wilson on April 13 sent to the Senate the appointments of the nine members of the Railroad Labor Board, which is to have jurisdiction over disputes between railroads and their employees. After considerable discussion the appointments were confirmed on April 15 and the board was at once called together by the President.

The board is composed of three representatives of the public selected by the President, three representatives of the railroad companies selected by him from six names nominated by the Association of Railway Executives, and three representatives of labor selected by the President from 10 nominations by the principal railroad labor organizations. The board is to select its own chairman and secretary and is to have its headquarters at Chicago, although it is authorized to hold meetings elsewhere. The members appointed by the President are:

Public Group: G. W. W. Hanger, assistant commissioner of the United States Board of Mediation and Conciliation; Henry Hunt, former mayor of Cincinnati and a member of the board of trustees of the Cincinnati Southern; and R. M. Barton of Memphis, Tenn., a former member of the Tennessee court of appeals.

Management Group: Horace Baker, former general manager of the Cincinnati, New Orleans & Texas Pacific; J. H. Elliott, former general manager of the Texas & Pacific and later a colonel in the Transportation Corps, A. E. F.; W. L. Park, former vice-president of the Illinois Central and later vice-president and federal manager of the Chicago Great Western.

Labor Group: Albert Phillips, vice-president of the Brotherhood of Locomotive Firemen and Enginemen; A. O. Wharton, president of the Railroad Employees Department of the American Federation of Labor and formerly a member of the Board of Railroad Wages and Working Conditions of the Railroad Administration; and J. J. Forrester, president of the Brotherhood of Railway and Steamship Clerks, Freight Handlers and Express and Station employees.

Messrs. Barton, Phillips and Baker are appointed for a term of three years, Messrs. Hanger, Wharton and Elliott for two years, and Messrs. Hunt, Forrester and Park for a term of one year.

Mr. Hanger has had an unusually broad experience in dealing with labor and wage matters during his service with the United States Board of Mediation and Conciliation, to which he was appointed in 1913 by President Wilson. He was formerly chief statistician of the Bureau of Labor Statistics. During federal control of the railroads he was an assistant to the director of the Division of Labor of the Railroad Administration. The other two representatives of the public on the board have not been identified with railroad labor questions.

The three representatives of labor on the board are entirely familiar with the questions to be handled by the board, both through long experience as labor leaders and because of their connection with the wage propositions which were submitted to the Railroad Administration and are still in an unsettled state. Mr. Wharton has been a member of the Board of Railroad Wages and Working Conditions, which has investigated all wage questions for the Railroad Adminstration since the issuance of General Order No. 27 in May, 1918, and, under the practice of that board of alternating the chairmanship between the representatives of the management and of the labor organizations, he has twice been chosen as chairman.

Mr. Baker had been general manager of the Cincinnati, New Orleans & Texas Pacific, with office at Cincinnati, from 1906 to March 1, 1920. He entered railway service as a clerk in 1878 and had later been chief clerk, trainmaster, local freight agent, division superintendent, assistant general superintendent and general superintendent. Mr. Elliott began railway work as a messenger and was later an operator, despatcher, chief despatcher and transmitter. Subsequently he was employed on the Texas & Pacific, the St. Louis & San Francisco and other roads in various capacities in the construction and operating departments. In 1914 he was appointed inspector of transportation of the Texas & Pacific and later he was promoted to superintendent, general superintendent and general manager. Mr. Park has also come up through the ranks and has had a great deal of experience in labor matters on both the side of the employees and on the side of the management. He entered railway service in 1875 as brakeman on the Union Pacific and was later freight conductor and passenger conductor, serving as chairman of the grievance committee for the conductors for a time. In 1900 he was appointed division superintendent and later general superintendent of the Union Pacific and in March, 1910, he was elected vice-president of the Illinois Central. In October, 1917, he was granted leave of absence by the Illinois Central for the duration of the war and was made first vice-president of the Chicago Great Western, later being appointed federal manager. He was a member of the board of arbitration that passed on the wage demands of the western enginemen and firemen in 1915.

Members of the board are to be paid $10,000 a year.

The board is directed by the law to hear and decide any dispute involving grievances, rules or working conditions in respect to which any adjustment board fails to reach a decision within a reasonable time, or, if no adjustment board has been organized, upon the application of the chief executive of a carrier or of a labor organization or of 100 unorganized employees, or upon its own motion if it is of the opinion that the dispute is likely substantially to interrupt commerce. It is also directed to receive for hearing and to decide disputes with respect to the wages or salaries of employees or subordinate officials. Decisions by the board require the concurrence of at least five of the nine members and in cases involving wages or salaries at least one of the representatives of the public must concur.

JAMES H. MANNING

James H. Manning, for 16 years superintendent of motive power of the Delaware & Hudson, died at Albany, N. Y., on April 15, at the age of 58. Mr. Manning's personality as well as his ability may be said to have dominated to an unusual degree the motive power department of the road with which he was connected for so many years and his death is a severe loss to the road and to the employees who regarded him as much their friend as their superior.

Mr. Manning was identified with the motive power department throughout his entire career and was remarkably successful in the administration of the wide range of executive as well as mechanical problems with which he was confronted. His official position, however, did not prevent him from retaining a warm personal contact with a large number of his employees and more than one young man in his service has been surprised by a genuine expression of sympathy or offer of assistance from his chief when circumstances were against him.

J. H. Manning

Mr. Manning entered railroad service in 1876 as a machinist on the Union Pacific. He was appointed a gang foreman in 1883 and a general foreman in 1886. In 1890 he was made master mechanic at Omaha and in 1898 was transferred to Cheyenne, in the same capacity. In 1901 he engaged in the foundry business, but in 1903 returned to the railroads as assistant superintendent of rolling stock on the Canadian Pacific. In 1904 he was appointed superintendent motive power on the Delaware & Hudson.

In recent years Mr. Manning's position placed upon him the responsibility for applying the crucial test to some remarkable developments in locomotive design. The Mallet locomotive, pulverized fuel and the feedwater heater he tested with characteristic thoroughness and persistency. It may be recalled that when Mr. Manning first tested the Mallet locomotive that had supplanted two Consolidation engines on his road, he found that the Mallet burned considerably less coal than the two Consolidations, but rather than satisfy himself with this result, he attacked the situation one year later and succeeded in securing a fuel consumption on the Mallet that was less than the fuel consumption of either of the Consolidation engines that it had replaced.

Mr. Manning needed to be sure of his ground and when his course was clear he invariably pursued it with vigor and success. He was the type of man most needed by the railroads for the mechanical problems with which they have been confronted and his loss will be keenly felt.

A Practical Freight Train Loading Method

A Simple Method for Finding the Car Factor and Equated Loading for Any Given Conditions

BY R. S. MOUNCE

Too strong emphasis cannot be placed on the importance of properly loading locomotives as a factor in increasing locomotive operating efficiency. It is almost obvious that a locomotive underloaded is wasting a portion of its hauling capacity and that one which is overloaded is retarding operation; in either case there is an economic loss.

Any train-loading method to be satisfactory must be easy to apply and should involve no loss of time in making up trains. For this reason no calculations should be left to the yard forces other than the necessary addition of gross car weights and the allowance for car friction. Allowance for car friction should be a constant quantity for a given weather condition on any division and of such a value that it will accurately equate any combination of car weights entering into the make-up of the train. It has been established that the friction allowance cannot be constant for all temperature conditions, because if it is correct for summer conditions it will be too small at low temperatures. This feature will be fully covered later.

The train-loading method given herewith has been thoroughly tested under a wide variation of weather conditions on both low grade and hilly railroads. The data have been reduced to graphic form where possible, and it is believed that the amount of calculation necessary to apply the method to specific conditions will be comparatively small.

Standard Loading Chart.—A standard loading chart showing the equated loading for an available drawbar pull of 10,000 lb. on grades from zero to two per cent, together with corresponding car factors, is taken as the basis for this train-loading method. A loading curve and its corresponding car factor are plotted for six different weather conditions in Fig. 1. It is assumed that these loading curves are applicable to speeds of from five to twelve miles per hour over ruling grades.

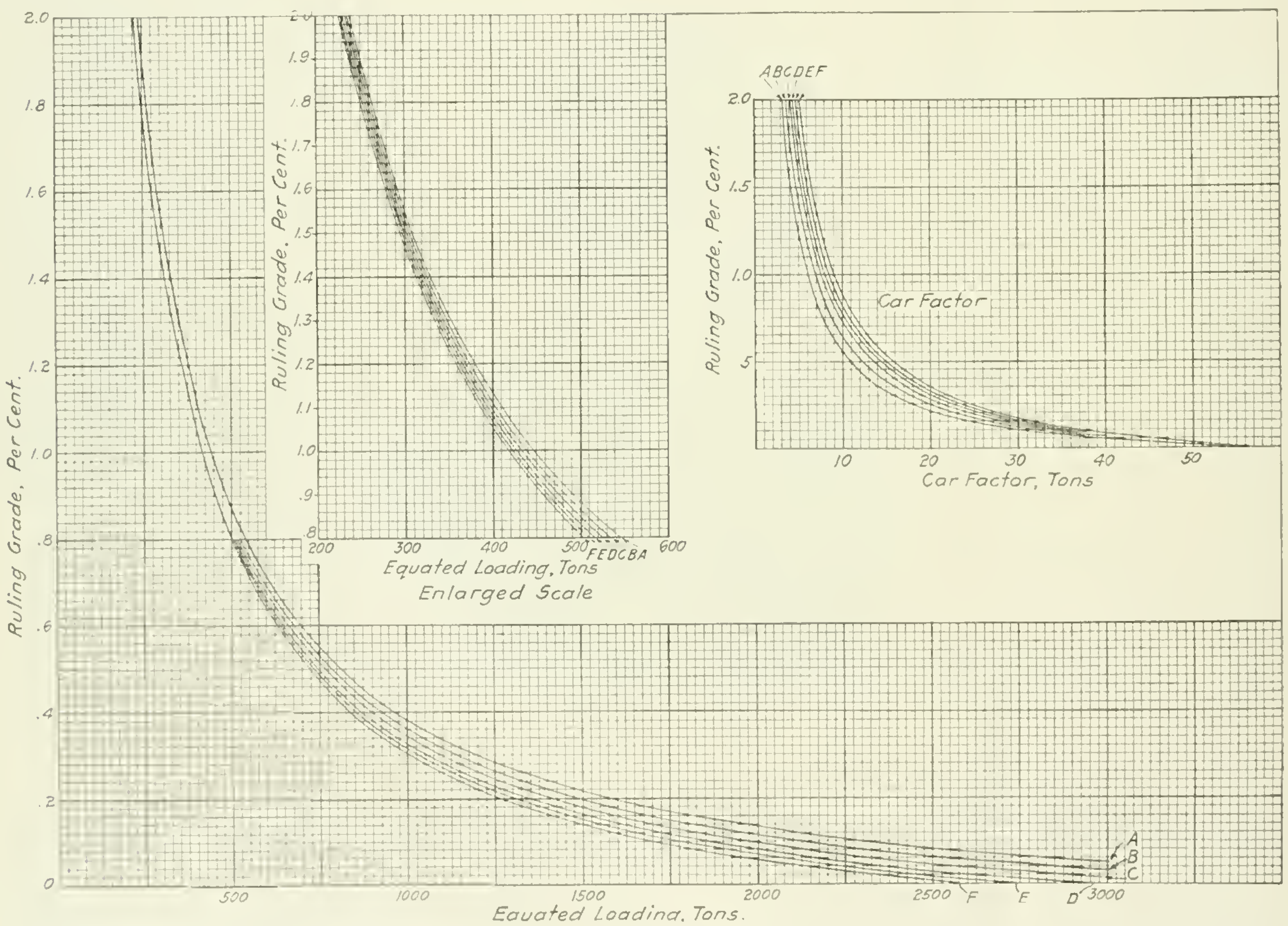


Fig. 1—Standard Loading Chart for 10,000-Lb. Available Tractive Effort at Speeds Between 5 and 12 M.P.H. Under Various Weather Conditions

Data for this chart are obtained in the following manner: Train resistances per ton for various car weights, as shown in the proceedings of the Master Mechanics' Association, for good average track conditions, were verified by further tests. These figures for 10 miles per hour were taken to be substantially correct for speeds between 5 and 12 miles per hour. The average increased train resistance per degree Fahrenheit drop in temperature has been shown by test to be .715 per cent.

The several temperature loadings are designated *A*, *B*, *C*, *D*, *E* and *F*, and the resistance per ton for cars of 70 and 20 tons gross weight as used in the chart are shown in the table below. The resistances for loadings *B* to *F*, respectively, are calculated, using the above data based on the figures 4.25 and 9.00 lb. per ton at loading *A*, for 70 and 20-ton cars, respectively.

Rating	Weather loadings: Temperature range deg. F.	Weather loadings: Average temp. deg. F.	Resistance, lb. per ton, on level tangent track: 70-ton cars	Resistance, lb. per ton, on level tangent track: 20-ton cars
A	50 and above	70	4.25	9.00
B	49 to 35	45	5.00	10.60
C	34 to 20	25	5.60	11.90
D	19 to 5	10	6.10	12.90
E	4 to —10	—5	6.50	13.80
F	—11 and below	—20	7.00	14.80

The formulæ used to derive the curves shown on the standard loading chart are:

70-ton cars—

$$\text{Train load (tons)} = \frac{P}{r}$$

$$\text{Number of cars in train} = \frac{P}{70\,R}$$

20-ton cars—

$$\text{Train load (tons)} = \frac{P}{R}$$

$$\text{Number of cars in train} = \frac{P}{20\,r}$$

$$\text{Car factor} = C = \frac{\frac{P}{R} - \frac{P}{r}}{\frac{P}{20r} - \frac{P}{70R}} = \frac{70\,(r - R)}{3.5\,R - r}$$

$$\text{Equated train loading} = \frac{P}{R} + \frac{PC}{70R} = \frac{P}{r} + \frac{PC}{20r}$$

Where P = Available tractive effort.
R = Total resistance, per ton for 70-ton cars.
r = Total resistance, per ton for 20-ton cars.

Applying these formulæ to one point on one of the curves, together with a check of the derived car factor to prove its accuracy in equating various car weights:

Assume:
Weather rating *A*
Equivalent grade, .5 per cent = G
P = 10,000 lb. (basic figure)

Then R = 4.25 + 20 G = 4.25 + 10 = 14.25 lb. per ton
and r = 9.00 + 20 G = 9.00 + 10 = 19.00 lb. per ton

$$\text{Car factor} = \frac{70\ (19.00 - 14.25)}{3.5 \times 14.25 - 19.00} = 10.7 \text{ tons}$$

$$\text{Equated train loading} = \frac{10{,}000}{14.25} + \frac{10{,}000 \times 10.7}{70 \times 14.25}$$

= 809 tons

$$\text{or} = \frac{10{,}000}{19.00} + \frac{10{,}000 \times 10.7}{20 \times 19.00} = 808 \text{ tons}$$

In this manner the series of equated train loading and car factor curves shown in Fig. 1 are derived.

Available Tractive Effort of Locomotives—Fig. 2 shows the per cent of the theoretical cylinder tractive effort at various piston speeds up to 600 ft. per minute for modern hand-fired locomotives, both with and without superheaters. These curves are derived from reliable test data and represent good average locomotive conditions, and give a basis for calculating available tractive effort at various speeds for modern locomotives, by using the following data and formulae.

$$\text{Piston speed (ft. per min.)} = 56 \times \text{m.p.h.} \times \frac{S}{D}$$

Where m.p.h. = Speed, miles per hour
S = Piston stroke, inches
D = Diameter of drivers, inches

Internal resistance of locomotive = sum of resistances of drivers, engine and tender trucks, and grade resistance.

1. Resistance of drivers, lb. = $W_D \times 22\frac{1}{2}$

2. Resistance of engine and tender trucks, lb. = $(W_{ET} + W_{TT} + W_T)\left(3 + \frac{V}{6}\right)$

3. Resistance due to grade, lb. = $W_{TOT} \times 20 \times G$

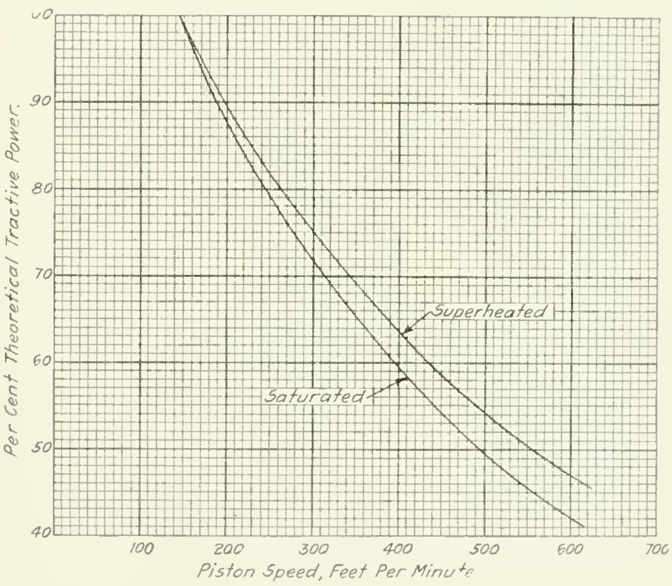


Fig. 2—Percentage of Theoretical Tractive Effort Developed at Various Speeds

W_D = Weight on drivers, tons
W_{ET} = Weight on leading truck, tons
W_{TT} = Weight on trailing truck, tons
W_T = Weight on tender, tons
W_{TOT} = Total Weight, engine and tender, tons
V = Speed, miles per hour
G = Equivalent grade, per cent

Available tractive effort = cylinder tractive effort — internal resistance of locomotive.

For each class of locomotive for which train loading data are desired, a chart showing the available tractive effort at various speeds over the range of grades encountered, should be prepared. The following example shows how easily this can be done:

Mikado Type Locomotive With Superheater, Class S-4.

Cylinders	28 in. by 32 in.
Drivers	63 in.
Boiler pressure	180 lb.
Weight on drivers	240,000 lb.

Weight on leading truck	29,000 lb.
Weight on trailing truck	52,500 lb.
Weight on engine, loaded	321,500 lb.
Weight on tender, loaded	162,500 lb.
Weight on engine and tender, loaded	484,000 lb.
Theoretical tractive effort (at 85 per cent B. P.)	60,900 lb.

Fig. 2 shows that the maximum tractive power is obtained from the starting speed up to a piston speed of 145 ft. per minute.

Substituting this value in the formula stated above:

$$145 = 56 \text{ x m.p.h. x } \frac{32}{63}$$

m.p.h. = 5.1, speed below which locomotive will give maximum available tractive effort.

At this speed, 5.1 miles per hour, the available tractive effort on level tangent track will be:

60,900 minus resistances 1, 2 and 3.

$$1.\ \text{Drivers} = \frac{240{,}000}{2{,}000} \text{ x } 22\tfrac{1}{2} = 2{,}700 \text{ lb.}$$

$$2.\ \text{Engine and tender trucks} = \frac{29{,}000 + 52{,}500 + 162{,}500}{2{,}000} \text{ x } \left(3 + \frac{5.1}{6}\right) = 470 \text{ lb.}$$

3. Grade = O

Sum of friction and grade resistances = 3,170 lb.

Available tractive effort = 60,900 — 3,170 = 57,730 lb.

For a three per cent equivalent grade at this speed, resistances 1 and 2 are the same as for level tangent track, but:

$$3.\ \text{Grade} = \frac{484{,}000}{2{,}000} \text{ x } 20 \text{ x } 3 = 14{,}200 \text{ lb., and the}$$

total friction and grade resistance = 17,370 lb.

Available tractive effort = 60,900 — 17,370 = 43,530 lb.

Plotting these two points on a chart, Fig. 3, and connecting them by a straight line, gives the available tractive effort over equivalent grades up to three per cent for locomotive Class S-4, at speeds below 5.1 miles per hour. Using the same formulae, available tractive effort curves for speeds of six, seven, eight, nine and ten miles an hour are plotted. These curves give complete available tractive effort data for Class S-4 locomotives. The same process is followed for the various classes of locomotives to be used, and these charts, of the form shown in Fig. 3, together with the standard loading chart, Fig. 1, make further calculations unnecessary and the process of obtaining standard loading over any division a comparatively simple one.

Application of the Method to a Given Set of Operating Conditions—Case I.—Typical hilly division with heavy ruling grade in one direction. Profile shown by Fig. 4, all grades compensated for curvature. The operating conditions on the *AB* division are assumed to be as follows:

Total time allowed for making a trip over the division in either direction, including terminal and road delays	8 hrs. 0 min.
Average terminal delays	1 hr. 0 min.

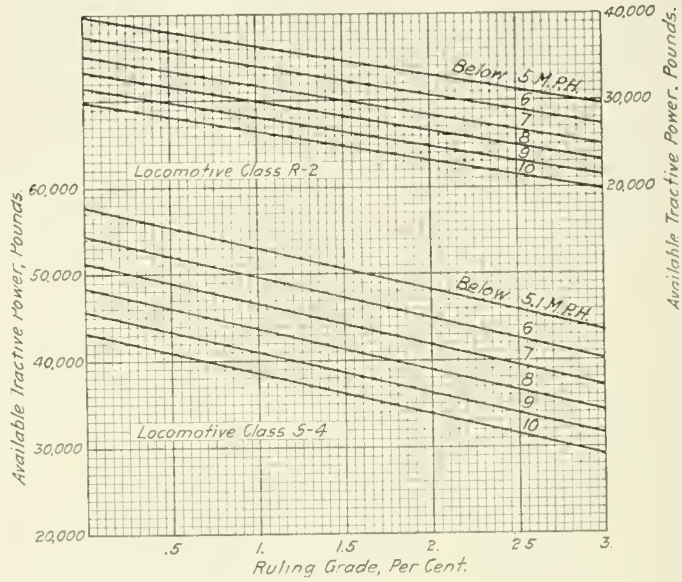


Fig. 3—Available Tractive Effort for Two Typical Locomotives Under Various Conditions of Speed and Grade

Taking water and other road delays	0 hr. 45 min.
Time left for making run within the eight hours	6 hrs. 15 min
Length of division	93 miles
Average speed over division	16½ m.p.h.

Northbound, the *AB* division has 46 miles of heavy ascending grade, 37 miles of low descending grade and 10 miles of level road. The descending grade and level portion can be covered in approximately one hour and 45 minutes, leaving four hours and 30 minutes to cover the 46 miles of ascending grade, over which the average speed will, accordingly, be slightly more than 10 miles per hour. This average speed can probably be maintained if the train loading is based on a speed of nine miles per hour over the .76 per cent ruling grade.

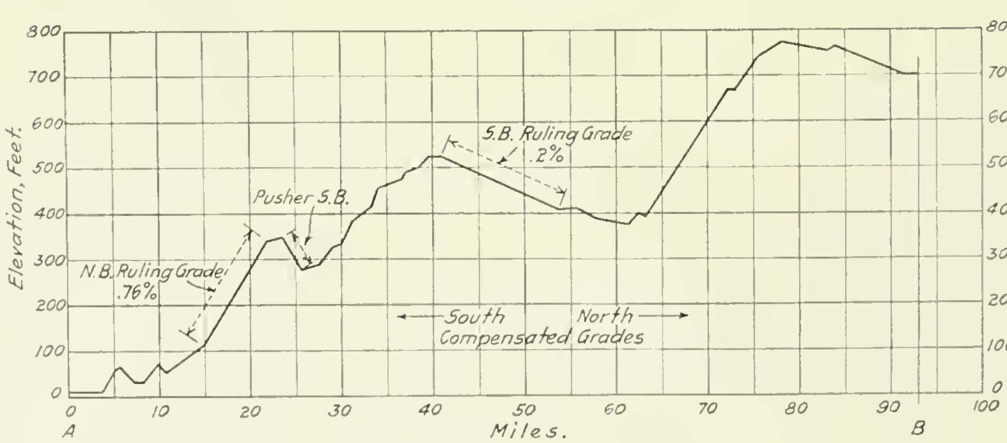


Fig. 4—Profile of the A-B Division

Southbound this division has 37 miles of low ascending grade and 46 miles of heavy descending grade and 10 miles of level road. The run over the descending grade and level

stretches will not require over two hours, leaving four hours and 15 minutes in which to make the 37 miles of ascending grade, at an average speed of 8.8 miles per hour. At a speed of 8.5 miles per hour over the .2 per cent ruling grade, which is 13 miles in length, this average speed should be easily maintained.

Assuming that train loading is desired for Class S-4 locomotives over the *AB* division, the procedure is as follows:

Northbound.—From Fig. 3, for the Class S-4 locomotive, the available tractive effort at nine miles per hour on the ruling grade of .76 per cent is 42,250 lb. (4,225 x 10,000 lb.) The standard train loading chart, Fig. 1, gives the following data for 10,000 lb. available tractive power on a .76 per cent grade:

Equated Loading for 10,000 Lb. Tractive Effort on .76 Per Cent Grade for Various Weather Conditions

Weather	A	B	C	D	E	F
Equated tons........	565	550	540	534	530	525

Multiplying these figures by 4.225 gives the equated loading for the S-4 locomotive.

The car factor for a .76 per cent grade, taken to the nearest one-half ton is:

Car Factor on .76 Per Cent Grade for Various Weather Conditions

Weather	A	B	C	D	E	F
Equated tons........	7½	8½	9½	10	11	11½

Southbound.—In a similar manner, for a .2 per cent grade and a speed of 8.5 miles per hour, the available tractive effort = 46.100 lb. (4.61 x 10,000 lb.) The equated loading for 10.000 available tractive power on .2 per cent grade is as follows:

Equated Loading for 10.000 Lb. Tractive Effort on .2 Per Cent Grade for Various Weather Conditions

Weather	A	B	C	D	E	F
Equated tons	1,570	1,480	1,405	1,345	1,305	1,265

Car Factor on .2 Per Cent Grade for Various Weather Conditions.

Weather	A	B	C	D	E	F
Equated tons	21	23	25	26	27	27½

The final train loading, Class S-4 locomotive over the *AB* division would then be:

Equated Train Loading for Class S-4, Tons

Northbound						
Weather	A	B	C	D	E	F
Car factor, tons.....	7½	8½	9½	10	11	11½
Equated tons, locomotive, Class S-4.....	2,387	2,324	2,282	2,256	2,239	2,218
Southbound						
Weather	A	B	C	D	E	F
Car factor, tons.....	21	23	25	26	27	27½
Equated tons, locomotive, Class S-4.....	7,235	6,825	6,475	6,200	6,015	5,830

Case II.—Typical low grade division. Profile shown by Fig. 5. All grades compensated for curvature.

The operating conditions on the *CD* division are assumed to be as follows:

Total time allowed for one way trip over the division, including terminal and road delays ....12 hrs. 0 min.
Average terminal delays .... 1 hr. 0 min.
Taking water and other road delays.... 2 hrs. 0 min.
Time left for making run within the 12 hours .... 9 hrs. 0 min.
Length of division ....138 miles
Average speed over division ....15 ⅓ m.p.h.

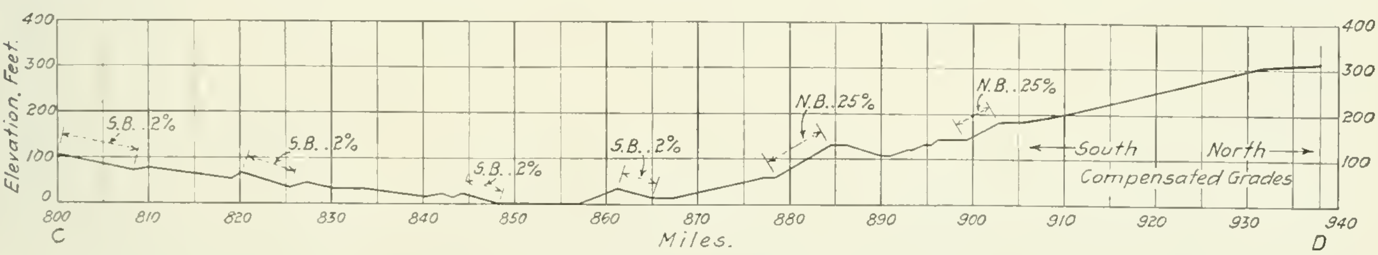


Fig. 5—Profile of the C-D Division

Northbound the *CD* division has 68 miles of slightly ascending grade, 45 miles of slightly descending grade and 25 miles of level road. The run over the level and descending portions of the division can be made in about three hours, leaving six hours in which to cover the 68 miles of ascending grade, at an average speed of 11.3 miles an hour. On account of the general low grade nature of this division, the ruling portion of which is but .25 per cent northbound, this average speed can probably be maintained if the train passes over the two ruling portions, of six and three miles in length, respectively, at a speed of 10 miles an hour.

Southbound, this division has but 45 miles of slightly ascending grade, 68 miles of slightly descending grade and 25 miles of level road. The descending and level parts of the division can be covered in approximately four hours, leaving five hours in which to traverse the 45 miles of ascending grade, at an average speed of nine miles an hour. For the reason that practically all of this grade is about .2 per cent, the maximum southbound grade, nine miles per hour is taken as the speed over the ruling grade.

On account of the prevailing general low grade character of the *CD* division a smaller locomotive than the Class S-4 Mikado is to be used, the Class R-2 superheated Consolidation type locomotive having been selected. Data regarding the available tractive effort for this class of locomotive are shown in Fig. 3.

Northbound.—The speed over the ruling grade is assumed to be 10 miles an hour. The available tractive effort at this speed over a .25 per cent grade is 29,000 lb., or 2.9 x 10,000 lb.

From the standard loading chart, Fig. 1, the loading data for 10,000 lb. available tractive effort on a .25 per cent ruling grade is found to be as follows:

Equated Loading for 10.000 Lb. Tractive Effort on .25 Per Cent Grade

Weather.............	A	B	C	D	E	F
Equated tons	1,195	1,140	1,095	1,060	1,037	1,012

The corresponding car factors are:

Weather	A	B	C	D	E	F
Car factor, tons.....	18	20	21½	22½	23½	24½

Southbound.—Similarly for a .2 per cent grade and a speed of nine miles per hour, the available tractive effort is 30,800 lb. or 3.08 x 10,000 lb. The equated loading for 10,000 lb. available tractive power on a .2 per cent grade and the car factors are:

Weather	A	B	C	D	E	F
Equated tons	1,570	1,480	1,405	1,345	1,305	1,265
Car factor, tons.....	21	23	25	26	27	27½

The final train loading for the Class R-2 locomotive over *CD* division would then be:

Equated Train Loading, Tons

Northbound						
Weather	A	B	C	D	E	F
Car factor, tons.....	18	20	21½	22½	23½	24½
Equated tons, locomotive, Class R-2....	3,465	3,305	3,175	3,075	3,005	2,935
Southbound						
Weather	A	B	C	D	E	F
Car factor, tons.....	21	23	25	26	27	27½
Equated tons, locomotive, Class R-2....	4,835	4,560	4,330	4,125	4,020	3,895

The foregoing method of freight train loading is working out very well in practice. To apply it successfully, it is of course necessary to have an accurate knowledge of the operating conditions, and profile and topography of that portion of the railroad under consideration. It is to be expected that slight changes will, in some cases, be necessary in the loading figures assigned from the standard charts used, dictated, of course, by service trials of the predetermined loadings. The basic idea in presenting this method of train loading is to afford a reasonably accurate means of loading locomotives to their economic capacity, without necessitating extensive tests to determine equated loads and friction allowances.

LOCOMOTIVES FOR THE BELGIAN STATE RAILWAYS

On March 1 the American Locomotive Company at its Schenectady works completed the first engine of the order recently placed by the Belgian State Railways. The contract for this order, which calls for 150 locomotives, 75 to be built by the American Locomotive Company and 75 by the Baldwin Locomotive Works, was signed in Brussels on December 13. It was not until December 24 that the engineering department of the American Locomotive Company was furnished the information necessary to enable it to proceed with the design of the locomotive. The design was entirely new and the metric system was used throughout, yet in 52 working days the first locomotive was completed.

While the locomotives are of American design in all their details, as will be noted from the photograph, the Belgian type of cab and tender were used. This was done in order to permit the American locomotives to couple with the existing Belgian tenders and vice versa. The Belgian State Railway's standard train connection of the screw link type with two spring buffers, the international system of threads, and French-Westinghouse brake equipment with French-Westinghouse pipe threads were also included.

These engines are to be used in both freight and passenger service and are designed for 16-deg. curves and a maximum grade of 3.3 per cent. Following European practice, all the engines are built for left-hand drive. All gages are graduated in kilograms per square centimeter.

The specifications called for a weight on drivers of 164,000 lb., weight on truck of 22,000 lb., total weight of engine 186,000 lb., and a weight limit per axle of 42,900 lb. The official scale weights are as follows:

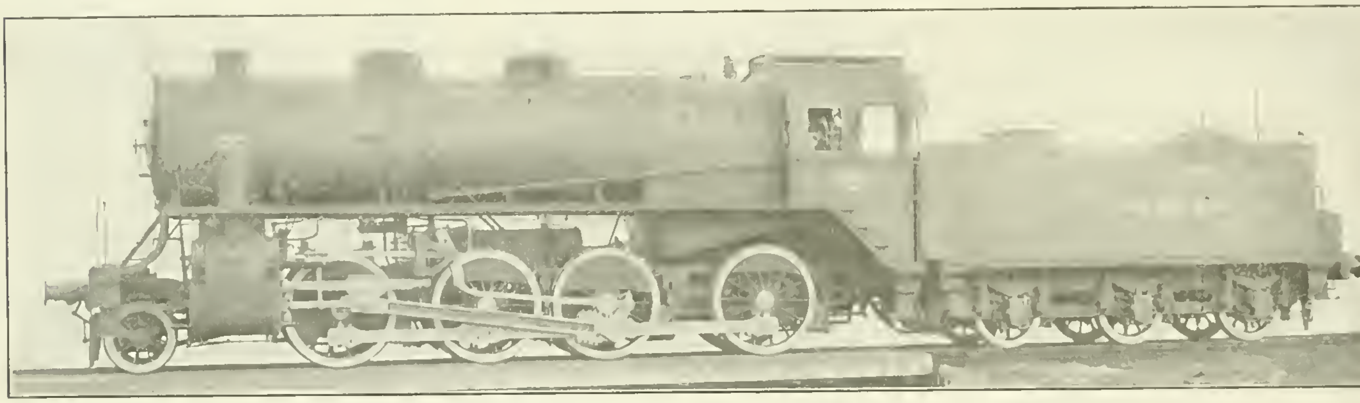
First driver	41,600 lb.
Second driver	41,600 lb.
Third driver	41,900 lb.
Fourth driver	41,900 lb.
Total drivers	167,000 lb.
Truck	21,000 lb.
Total engine	188,000 lb.

The boiler is of the straight top type, 68 in. in diameter at the front end. It carries 200 lb. steam pressure and has a copper fire box 96 in. by 60¼ in. All staybolts are of copper, with a tell-tale hole drilled in both ends. The firebox is supported at the front end by a sliding shoe, with a brass wearing plate and a large oil groove. The jacket is supported on a crinoline frame and is extended to the front end of the smokebox. A brick arch supported on tubes and a Locomotive Superheater Company's type A superheater are also included.

The counterbalance for the reciprocating parts was divided among the eight coupled wheels, and had to be such that the dynamic augment should not exceed 15 per cent of the static weight on the rail at 60 km. (37.3 mi.) per hour.

The last five of the locomotives to be built by the American Locomotive Company are to be equipped with Worthington feedwater heaters.

The tender frame is made of steel plate and is supported on three pairs of wheels held in rigid pedestals, the tender tank being arranged so as to drop down in between the frame.



Consolidation Type Locomotive for Belgium Built in Record Time

General Data

Gage	1.435 m. (4 ft. 8½ in.)
Service	Passenger and freight
Fuel	Bituminous coal
Tractive effort	15,800 kg. (34,800 lb.) at 65 per cent m. e. p.
Weight in working order	85,276 kg. (188,000 lb.)
Weight on drivers	75,750 kg. (167,000 lb.)
Weight on leading truck	9,526 kg. (21,000 lb.)
Weight of engine and tender in working order	138,619 kg. (306,000 lb.)
Wheel base, driving	5.941 m. (19 ft. 6 in.)
Wheel base, total	8.532 m. (28 ft.)
Wheel base, engine and tender	16.344 m. (53 ft. 8 in.)
Weight on drivers ÷ tractive effort	4.79

Cylinders

Kind	Simple
Diameter and stroke	.610 m. by .711 m. (24 in. by 28 in.)

Valves

Kind	Piston
Diameter	.305 mm. (12 in.)
Greatest travel	165 mm. (6½ in.)
Outside lap	27 mm. (1 1/16 in.)
Inside clearance	3 mm. (.118 in.)
Lead in full gear	4.5 mm. (.177 in.)

Wheels

Driving, diameter over tires	1.520 m. (60 in.)
Driving, thickness of tires	76 mm. (3 in.)
Driving journals, main, diameter and length	263 in.
Engine truck wheels, diameter	.90 m. (35½ in.)

Boiler

Style	Straight top
Working pressure	14 kg. per sq. cm. (199.3 lb. per sq. in.)
Outside diameter of first ring	1,694 m. (66¾ in.)
Firebox, length and width	2.438 m. by 1.530 m. (96 in. by 60¼ in.)
Firebox plates, thickness	16 mm. (⅝ in.)
Firebox, water space	Front, 102 mm. (4 in.); sides and back, 89 mm. (3½ in.)
Tubes, number and outside diameter	160—51 mm. (2 in.)
Flues, number and outside diameter	26—137 mm. (5⅜ in.)
Tubes and flues, length	4.724 m. (15 ft. 6 in.)
Heating surface, tubes and flues	171.7 sq. m. (1,847 sq. ft.)
Heating surface, firebox, including arch tubes	15.7 sq. m. (169 sq. ft.)
Heating surface, total	187.4 sq. m. (2,016 sq. ft.)
Superheater heating surface	45 sq. m. (484 sq. ft.)
Equivalent heating surface*	254.9 sq. m. (2,742 sq. ft.)
Grate area	3.7 sq. m.

Tender

Tank	Water bottom
Frame	Steel plate
Wheels, diameter	1.067 m. (42 in.)
Water capacity	24,000 litres (6,350 gal.)
Coal capacity	7,000 kg. (7.72 tons)

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

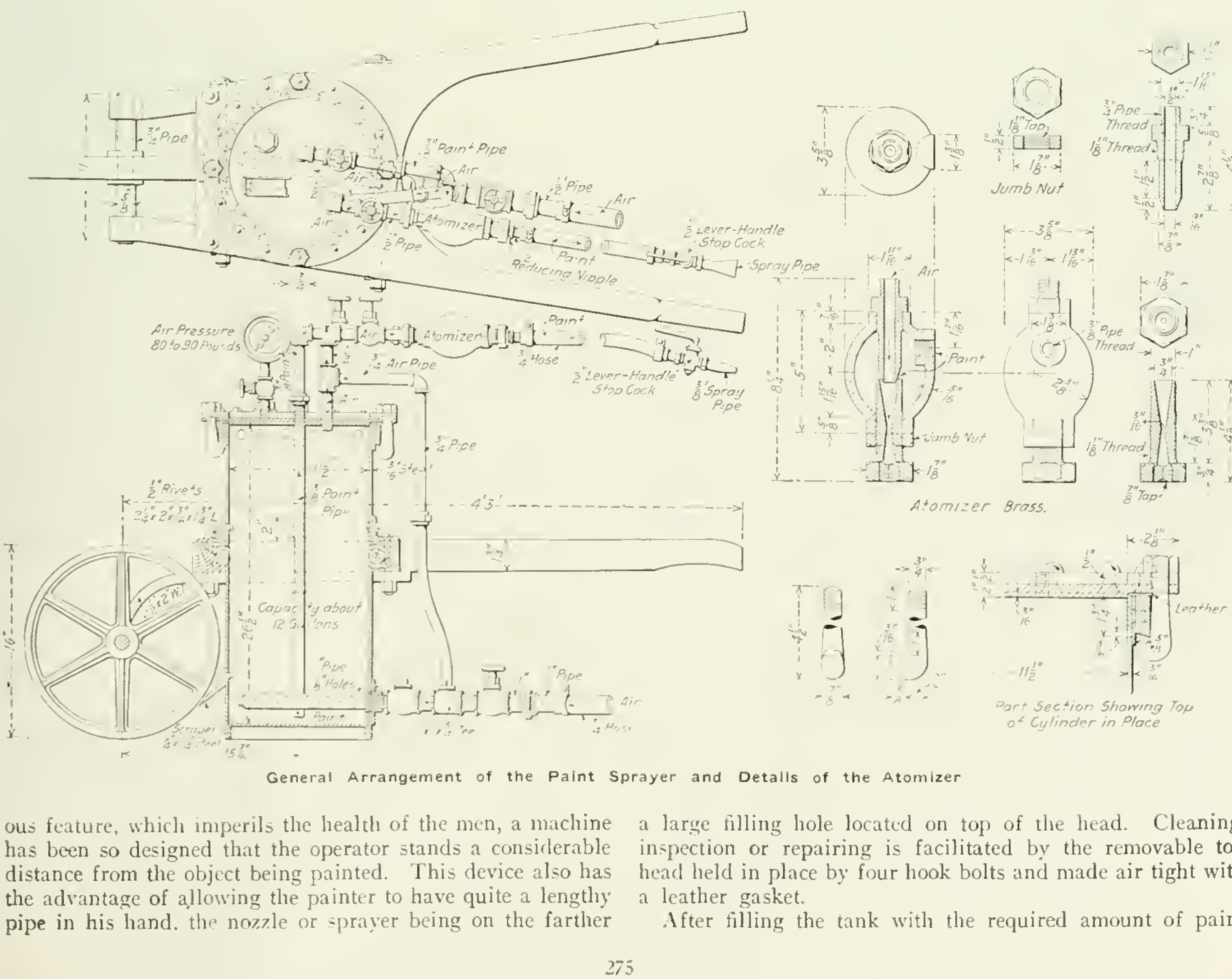
CAR DEPARTMENT

PNEUMATIC FREIGHT CAR PAINTING MACHINE

BY NORMAN McCLEOD

Considerable objection has arisen against a number of paint spraying machines used in painting freight cars, the workmen complaining of inhaling the spray when operating these appliances due to the operator having to stand too close to the outlet of the sprayer. In order to eliminate this serious feature, which imperils the health of the men, a machine has been so designed that the operator stands a considerable distance from the object being painted. This device also has the advantage of allowing the painter to have quite a lengthy pipe in his hand, the nozzle or sprayer being on the farther end and a considerable distance from his face, while with the ordinary spraying machine the spraying pipe or nozzle is practically no farther removed than the length of the operator's arm.

The machine consists of a cylindrical 3/16 in. steel tank 11½ in. by 26½ in. inside dimensions, mounted on a wheelbarrow framework which facilitates handling. The filling of the tank with paint is done with a funnel through a large filling hole located on top of the head. Cleaning, inspection or repairing is facilitated by the removable top head held in place by four hook bolts and made air tight with a leather gasket.



General Arrangement of the Paint Sprayer and Details of the Atomizer

After filling the tank with the required amount of paint

air pressure (80 to 90 lb. per sq. in.) is introduced in two places, first through a 1 in. check valve and a perforated 1 in. pipe at the bottom of the tank and an auxiliary ¾ in. connection leading off from the 1 in. by 1 in. by ¾ in. tee between the main supply globe and check valves to a tee on a ½ in. vertical pipe in the top head. At this tee the air is diverted allowing pressure to go in the top of the tank and to the atomizer, where it is joined by the paint, brought to the atomizer through a ⅜ in. pipe the end of which reaches within ½ in. of the bottom of the tank.

Characteristics of Soft Metal Bearings*

Discussion of the Properties Resulting from Different Compositions and Pouring Temperatures

BY W. K. FRANK

A BEARING may be defined as that member of a mechanical device which constrains a moving part in its travel. The most common type is the axle or journal bearing used in all machines having rotating journals. It may completely surround the journal or may cover only a portion of it. The journal may rotate continuously, may rotate intermittently, or may have reversing rotation. The bearing may be subjected to pressure from one direction only, as in electric motors; alternating pressure, as in engine crank-pin bearings; or alternating pressure, combined with reversed rotation of the shaft, as in engine wrist-pin bearings.

Tilting Furnace in a Bronze Foundry

It may be well to show, in passing, the position covered by plain bearings—that is, those of sliding contact—as opposed to ball- or roller-bearings, called bearings of rolling contact. Plain bearings furnish a rugged construction which is subjected to every kind of mistreatment to which a mechanical part is heir, and in the great majority of cases they do their work satisfactorily. They operate under heavy impact, continuing perhaps a thousand times a minute and 24 hours a day; in acid fumes; sometimes with scanty lubrication; under dirt or at an intense heat; often improperly aligned and momentarily required to reseat the shaft. Roller bearings are admirably fitted for certain classes of service, but the necessity of the balls or rollers being made and maintained in a condition of extreme accuracy, measured in ten-thousandths of an inch, makes them impractical under the heat at which a rolling-mill bearing or wrist-pin bearing operates. The inherent limitations of design of the rolling type prevent any considerable adjustment to compensate for the wear, which does occur, and the replacement of this product of the highest mechanical skill requires an expenditure which is not inconsiderable.

The reduction in friction, and consequent saving in power, effected by rolling bearings is a potent argument in their favor, and were it not for the limitations of application for the reasons given, this type would have found much more general application. It will, therefore, be seen that plain bearings serve a particular field and that they are called upon to render service under trying conditions.

Properties of Bronze and Babbitt Bearings

The material from which a bearing is made plays a large part in design. While bronzes and babbitts are the principal

* From a paper presented before the Engineer's Society of Western Pennsylvania. The author is vice-president of the Damascus Bronze Co., Pittsburgh, Pa.

materials used, cast-iron, wood, fiber, etc., answer for some conditions. Very little wear has been observed from some cast-iron bearings, but it should be noted that good lubrication was provided and the pressures and rubbing speeds were low. The choice between babbitt and bronze will be made from considerations of speed, pressure and temperature of operation, as will be shown later. Babbitts are softer and have lower melting points than bronzes, and are therefore adapted to conditions of lower pressure and temperature. Bearings subjected to impact should not be made from babbitts, because of the malleability of these alloys. The lower melting points and malleability of babbitts are, however, the properties that make them easy to handle and they are for this reason widely used. Accurate bearings may be secured without expensive machining, or they may be die cast and made into intricate shapes without any machining whatsoever. Their plastic character allows them to conform to the load and prevents localized pressures. Bronzes, on the other hand, have comparatively high melting points and are, therefore, not so easily handled. They are generally furnished by a bronze foundry in the form of castings, whereas babbitts are supplied in ingot form for application directly by the equipment builder and user.

Pit Furnaces Operated with Oil and Gas.

Bearing metals are essentially a mixture, the components of which are distinctly different in hardness. In these metals the softer crystals are abraded faster and develop into depressions, allowing the harder ones to stand above them and support the load. These softer crystals perform another function also. A bearing should be plastic to a limited degree, since fitting is more or less of a rough approximation. Furthermore, a change in alinement of the shaft will produce points of concentrated pressure and the bearing must be capable of reseating itself to distribute its load properly.

Another bearing requirement is that it shall protect the shaft against injury. Unfortunately, wear is always an attendant evil of motion, and it is preferable that the bearing wear rather than the shaft. In most designs the bearing is the less costly part and is the more easily replaced, hence its harder element should be softer than the shaft. The bearing should also be of such a nature that it will not grip or be capable of welding itself to the shaft in case it becomes heated, as serious damage will be done should this occur.

It will, therefore, be seen that the range of selection for bearing metals has been greatly limited by these considerations. The use of pure metals has been excluded because of the necessity for components with greatly dissimilar wearing properties. We are, therefore, dependent on alloys, and on those alloys of which the harder crystals are softer than the shaft; which are capable of conforming to the load and yet able to carry it without rupture or undue distortion; and which do not tend to weld on heating. Other considerations require that these alloys conduct and radiate the heat of friction readily, that they wear slowly and show small friction and that they be capable of uniform production.

The only alloys we know of which combine the desired properties are the bronzes and babbitts. Babbitts fall into two general classes — namely, the tin-base metals and the lead-base metals. Antimony, copper and zinc are the principal ingredients with the tin and lead, but sodium, cadmium, calcium, barium, bismuth, nickel or aluminum are added in some cases.

The tin-base, or so-called "genuine babbitts," are variations of Isaac Babbitt's original formula of 89.3 per cent tin, 3.6 per cent copper, 7.1 per cent antimony, and they vary in the percentages of all of these elements and sometimes contain lead or other metals. In these alloys the tin furnishes a plastic matrix, in which are embedded the harder crystals of the tin-antimony, copper-tin or copper-antimony compounds.

A microphotograph of a tin-base metal is shown in Fig. 1. The dark background is the plastic tin matrix, the cubical crystals the tin-antimony compound and the six pointed "snow crystals" the copper-tin compound. In the lead-base alloys the hard crystal forming elements are principally antimony and tin. The matrix is lead, an alloy of lead and tin, or the lead-antimony tin eutectic, and the hard crystals are usually the antimony-tin compound.

Fig. 1. Tin-Base Babbitt, Magnified 75 Diameters, Etched with Five per cent HNO_3

In Fig. 2 is shown a typical lead-base structure, with the soft eutectic forming the supporting medium for the hard, cubical, tin-antimony crystals. In the case of lead hardened with sodium, cadmium, etc., these elements probably form compounds with the lead, the compounds constituting the hard crystals embedded in the lead matrix. Lead-base babbitts present a wide range of compositions and are commonly composed of lead, tin and antimony. With a variation possible in each of these elements, it may easily be seen that almost an infinite number of combinations may be made. The lead is varied between 65 and 90 per cent, the tin between 0 and 40 per cent and the antimony between 5 and 20 per cent. Varying physical properties are obtained by different formulas, and selection of the proper one is determined by the character of the load, hardness of the journal, lubrication, pressure and speed.

Babbitts are covered by tentative specification B 23-18 T of the American Society for Testing Materials (Table 1). The physical properties appended to the specification (Table 2) do not form part of it, but are merely to be taken as infor-

mation regarding the properties that might be expected from carefully manufactured alloys. It will be seen that the Brinell hardness (all Brinell figures in this paper refer to a 300-kilogram load on a 10-millimeter ball, applied for 30 seconds) varies from 14.3 in the lead-base to 34.4 in the tin-base, and that the deformation with a load of 10,000 lb. varies from 0.007 in the tin-base alloys to 0.285 in the lead-base alloys. These properties indicate why tin-base alloys are preferred for some services, in spite of their higher cost.

It has been pointed out that pouring temperatures of babbitts largely influence their resistance to continued impact. The properly prepared tin-base alloys showed little difference in this particular from the properly prepared lead-base alloys, but it was stated that the allowable pouring temperatures of the tin-base babbitts showed a greater range than the temperatures for lead-base babbitts. The former are, therefore, more often properly poured and show better properties.

TABLE I

A. S. T. M. BABBITTS. SPECIFICATION B 23—18 T

Alloy, grade No.	Tin, per cent	Antimony, per cent	Lead, per cent	Copper, per cent	Iron, max., per cent	Arsenic, max., per cent	Zinc, per cent	Aluminum, per cent
1	91	4½	0.35*	4½	0.08	0.10	none	none
2	89	7½	0.35*	3½	0.08	0.10	none	none
3	83⅓	8⅓	0.35*	8⅓	0.08	0.10	none	none
4	75	12	10	3	0.08	0.15	none	none
5	65	15	18	2	0.08	0.15	none	none
6	20	15	63½	1½	0.08	0.15	none	none
7	10	15	75	0.50*	....	0.20	none	none
8	5	15	80	0.50*	....	0.20	none	none
9	5	10	85	0 50*	....	0.20	none	none
10	2	15	83	0.50*	....	0.20	none	none
11	..	15	85	0.50*	....	0.25	none	none
12	..	10	90	0.50*	....	0.25	none	none

*Maximum.

Babbitts as a class show high plasticity combined with low Brinell hardness and compression strength, and these properties limit their application. Bronzes are, therefore, used where higher physical properties are desired to resist pressure or impact, or to provide longer service. Whereas, in the case of the babbitts the softer element is the major constituent, so in the bronzes it is the minor constituent. Bearing bronzes are, in general, copper-tin matrices filled with lead. The term bronze applies strictly to a copper-tin mixture as differentiated from brass—a copper-zinc mixture. These terms are frequently loosely used, and it is quite common to speak of bearings as "brasses." On the other hand, manganese bronze, "Tobin" bronze and a multitude of other so-called bronzes are in reality brasses, to which possibly one or two per cent tin has been added; and aluminum bronze is usually a mixture of copper and aluminum, sometimes with a small quantity of iron.

The American Society of Mechanical Engineers Committee on Bearing Metals recently pointed out why bronze is preferred to brass in bearings. This has long been understood, and the explanation given is undoubtedly the proper one. In the case of a bronze bearing metal of 90 copper, 10 tin, we secure a mixture of at least two dissimilar crystals and possibly three. In the case of copper and zinc, only one set of crystals is formed, up to a high zinc content. A homogeneous mass is formed as contrasted with the non-homogeneous mass of hard and soft elements in the copper-tin alloy, and the latter mixture is desirable because of the formation of the minute oil reservoirs. The shop man will tell you that, in a bearing, brass is dry and harsh as compared with bronze, and it is undoubtedly the property of providing oil cells that gives bronze its value as a bearing metal.

Copper-tin mixtures have good hardness and compression strength. An increase is noted with additions of tin up to about 30 per cent, although at about 12 per cent brittleness begins, owing to the increase in the eutectoid or "bronzite" constituent. Some bearings which require high compressive strength contain more than 12 per cent tin, but they should be used with caution. The 90 copper, 10 tin alloy shows Brinell hardness of about 70 and compression of 0.20 on a one-inch cube under 100,000 lb. per sq. in.

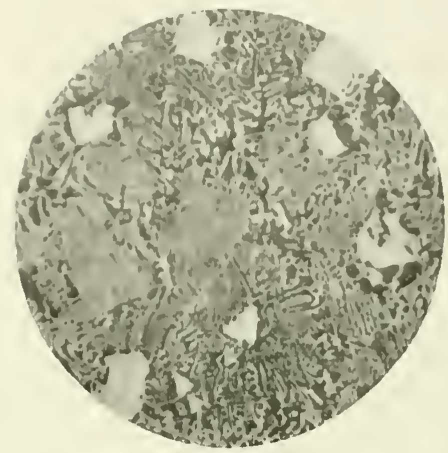


Fig. 2. Lead-Base Babbitt, Magnified 75 Diameters. Unetched

The majority of copper-tin bearings contain less than 12 per cent tin and combine hardness with ductility. They are limited to service where alinement is good, as they do not possess sufficient plasticity to conform readily to a shifting load. They find use in some machine tools and similar equipment, where good alinement may be maintained, and are used abroad on some railroad equipment where speeds and pressures are not excessive and where fitting is carefully performed. With ideal service conditions, a copper-tin bearing will probably outwear bearings containing added metals, but in most classes of service localized pressures caused by changing alinement will produce rapid wear and heating in this composition. Zinc is sometimes added to copper-tin mixtures,

TABLE II

A. S. T. M. TABLE SHOWING PHYSICAL PTOPERTIES OF WHITE METAL BEARING ALLOYS (APPENDIX TO SPECIFICATION B 23—18 T)

	Formula				Deformation of cylinder 1¼ in. diam. by 2½ in. high at 70° F., in.			Brinell hardness		Melting point		Complete liquation point			Weight		Proper pouring temperature,
Alloy No.	Copper, per cent	Tin, per cent	Antimony, per cent	Lead, per cent	At 1,000 lb.	At 5,000 lb.	At 10,000 lb.	At 70° F.	At 212° F	Deg. F.	Deg. C.	Deg. F.	Deg. C.	Specific Gravity	Oz. per cu. in.	Grams per cu. in.	deg. F.
1	4.5	91.0	4.5	....	0.000	0 001	0.015	28.6	12.8	437.0	225	699.8	371	7.34	4.24	120.28	824
2	3.5	89.0	7.5	....	0.0000	0.0015	0.0120	28.3	12.7	460.4	238	683.6	362	7.39	4.27	121.10	808
3	8⅓	83⅓	8⅓	....	0.0010	0.0045	0.0070	34.4	15.7	462.2	239	791.6	422	7.46	4.31	122.25	916
4	3.0	75 0	12.0	10.0	0.0005	0.0025	0.0090	29.6	12.8	365.0	185	555.8	291	7.52	4.35	123.23	680
5	2.0	65.0	15 0	18.0	0 0010	0.0030	0.0090	29.6	11.8	365 0	185	536.0	280	7.75	4.48	127.00	661
6	1.5	20.0	15.0	63.5	0.0015	0.0050	0.0180	24.3	11.1	365.0	185	512.6	267	9.33	5.39	152.89	638
7	...	10.0	15.0	75 0	0.0010	0.0050	0.0230	24.1	11.7	464.0	240	500.0	260	9.73	5.62	159.44	625
8	...	5 0	15.0	80.0	0.0020	0.0090	0.0620	20.9	10.3	469.4	243	500.0	260	10.04	5.80	164.52	625
9	...	5 0	10.0	85.0	0.0040	0.0120	0.0840	19.5	8.6	469.4	243	491.0	255	10.24	5.92	167.80	616
10	...	2.0	15 0	83.0	0.0010	0.0100	0.1540	17.0	8.9	473.2	245	500.0	260	10.07	5.82	165.02	625
11	...	....	15.0	85.0	0.0010	0.0100	0.1190	17.0	9.9	476.8	247	500.0	260	10.28	5.94	168.46	625
12	...	....	10 0	90.0	0.0025	0.0170	0.2850	14.3	6.4	476.8	247	509.0	265	10.67	6.17	174.85	634

and the familiar gun-metal is composed of 88 copper, 10 tin, 2 zinc, but the most widely used bearing mixture is the copper-tin-lead bronze.

In bronzes containing lead, the reservoir-forming property is further enhanced. The lead does not combine with the copper-tin structure, but is only mechanically held by it in the form of globules. It imparts plasticity to what would otherwise be a more or less rigid structure, in addition to furnishing it with additional oil reservoirs.

A typical copper-tin-lead bronze is shown in Fig. 3. The light colored matrix is the harder copper-tin structure, while the light globules surrounded by dark margins are of similar composition, but richer in copper and softer than the matrix. The black globules are the lead and are still softer. It will, therefore, be seen that three distinct hardnesses are present. In this mixture we maintain the hard, wear-resisting points of the copper-tin alloy and can vary plasticity by varying the lead content. The lead can be added up to 50 per cent, and this variation gives the different properties required by varying classes of service. In some cases a very small quantity of lead is added. It produces hot shortness and is therefore not desirable in hot-mill bearings. These may run at very high temperatures, and bearings containing much lead will break under the pressures encountered. A typical low-lead formula of this type would be 91 copper, 8 tin, 1 lead.

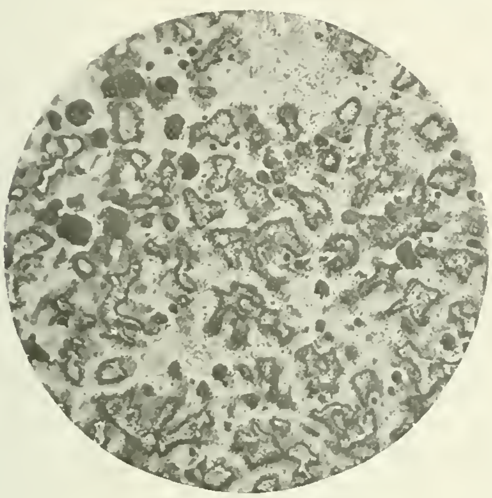


Fig. 3. Copper-Tin-Lead Bronze, Magnified 100 Diameters. Etched with $H_2O_2 + NH_4OH$

At the other end of the scale are found the high-lead mixtures containing up to 30 per cent lead. They find limited application because of their high plasticity and consequent distortion. They answer well the requirement of protecting the shaft, but do not, on the other hand, transmit heat readily. They show rapid wear, as is evident to anyone who has examined a pile of scrapped railroad car bearings. The high-lead bearings can be readily distinguished from the moderately leaded ones by the extent to which the axle collar has worn into the ends of bearings of the two classes. High-lead mixtures were originally designed to replace the babbitt-lined railroad car bearings, but do not possess sufficient plasticity to accomplish this and are used with babbitt linings. Because of this lining they seldom come in contact with any part of the journal, excepting the collar, and their length of service is determined by the life of the lining, distortion of the back and collar wear.

It is, moreover, true that high-lead mixtures are difficult of uniform production. Since the lead is but mechanically mixed with the copper-tin alloy, and as lead has a much higher specific gravity, segregation to a greater or less degree is liable to occur in the crucible and mold. Lighter castings which cool quickly can be made with some degree of success, but lead segregation of heavy castings is an accepted evil. Auxiliary agents, including nickel, ferro-manganese and sulphur, are used as preventatives of segregation, but these are not reliable expedients. Referring again to the scrap pile—the testing laboratory of experience—bad segregations in fractures of a large number of high-lead bearings are revealed. While it is not stated that castings cannot be produced without segregation, it is true that this mixture is easily mishandled and bad bearings result. Unfortunately, low initial cost has recommended it to some users. Conservation of tin during the war led the United States Railroad Administration to specify high-lead bearings for the new cars purchased. The bearing manufacturers will benefit by the replacement that will inevitably be required. A typical mixture consists of 65 copper, 5 tin, 30 lead.

As in many matters, the best lies between the extremes, and in this case the moderately leaded bronzes best answer most bearing requirements. They can be produced uniformly and well, as no great difficulty is experienced from segregation of the lead. Alloys of this class range from 5 to 15 per cent lead, and 12 to 7 per cent tin, with the remainder copper. Copper, tin and lead all tend to form oxides readily, and deoxidizers are often added. Phosphorus is the most effective of these, and is usually added in quantities in excess of that required for deoxidization and produces an additional hard constituent in the bronze. Phosphor-bronze, as the resulting alloy is called, is one of the most valuable of alloys in present-day use, for a great variety of requirements. It presents a comparatively hard surface, and yet is sufficiently plastic to conform to moderate changes in alinement. It answers all the essentials of a good bearing, for moderately good conditions of service. The standard formula calls for 79.7 copper, 9.5 lead, 10 tin, 0.8 phosphorus, and should specify less than ½ per cent impurities, as too often scrap metals are compounded to produce this alloy and the resulting trouble is charged to the formula, rather than to the impurities contained. For varying degrees of hardness the lead and tin may be varied between certain well-defined limits. The standard formula shows Brinell hardness 60, and compression of 0.25 on a one-inch cube under 100,000 lb. per sq. in.

As far back as 1892 Dr. Dudley of the Pennsylvania Railroad determined the practical limitation of lead content for car bearings to be in the neighborhood of 15 per cent. Later work on this subject has not altered the conclusions he reached in this respect, and it may be of interest to note that 27 years later a table of railroad specifications shows the net average content of 15 per cent lead and 8 per cent tin. Dr. Dudley's experiments were real service tests. It should be remembered, however, that while the 12½ per cent lead and 15 per cent lead alloys wore more slowly than phosphor-bronze in railroad car bearings, this is not conclusive proof that the lead is in itself a wear-retarding element. Lead furnishes the means of allowing the bronze to conform more readily to varying alinement and, by preventing localized pressures, reduces wear. Under the comparatively low pressures and absence of impact, but with the changing alinement of car axles, the 15 per cent lead alloy shows superiority; whereas, under high pressures and impact the phosphor-bronze shows slower wear. It is necessary only to compare the pressures of car axles of 325 lb. per sq. in. of projected area with pressures of 3,500 lb. per sq. in. of projected area, encountered in rolling-mill practice, to demonstrate why 15 per cent lead alloys are not suitable for the latter condition.

Heavy cuts in machining may seriously injure a bearing bronze. Some years ago trouble was experienced by heating in the driving-wheel bearings in new locomotives of one of the railroads. Our company had furnished the bearings and we were called upon to explain the trouble. Chemical analysis of the bronze was made and found satisfactory. The fracture revealed nothing to the naked eye, but when a section was

polished and placed under the microscope the condition shown in Fig. 4 was noted at the machined edges; whereas, normal structure, as in Fig. 5, was found in the interior points. It was then apparent that heavy cuts in machining had actually forced a large part of the lead from the copper-tin-sponge, and a rigid structure was the result. It was suggested that ⅛ in. be machined from the bearing journal surface to eliminate this distorted metal, and after this was done no further heating was experienced.

Some explanation should be made of the lack of suitable bearing testing machines. It is true that some machines have

Fig. 4. Distorted Bearing Bronze, Magnified 100 Diameters. Unetched

been designed, but their value lies mainly in the testing of the lubricant. It is practically impossible to duplicate service conditions on the present types of apparatus and, from the foregoing discussion of variations in lubrication and of shifting pressures, this may be understood. With imperfect lubrication, large differences on the same identical test bearing will be noted on different days, and the explanation probably lies in the varying approaches to perfect lubrication obtained.

Tensile and compression tests are sometimes employed to check the uniformity of a given formula, but their extended use is more or less limited by considerations of the expense

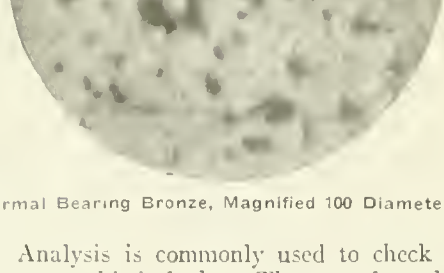


Fig 5. Normal Bearing Bronze, Magnified 100 Diameters, Unetched

involved. Analysis is commonly used to check the desired formula, but even this is faulty. The same formula may show large variations in structure caused by different pouring temperatures, or rates of cooling. Structure is obviously the factor which determines the bearing value and, while a microscope may show the arrangement of the elements, it does not measure hardness or plasticity. The Brinell or other hardness value does not give much information. Little can be expected at present from inspection tests.

As in many other fields, a reliable manufacturer should be consulted for his experience with similar conditions. When suitable alloys are obtained he should be required to maintain uniformity of properties in the alloys subsequently delivered. It should be pointed out that the use of scrap mixtures is a common source of the varying service obtained in bearings and that uniform results can be obtained only from alloys composed of new metals, produced with standardized melting and molding practice. Unfortunately, initial price considerations sometimes rule in the purchase of bearing alloys, and the final cost per unit of service is much higher than would be the case with a slightly higher initial outlay.

Discussion

In the discussion following the presentation of this paper, John S. Unger, manager of the Central Research Bureau of the Carnegie Steel Company, stated that he believed the common practice of purchasing bearing metal of either bronze or white metal by analysis was wrong. He expressed the opinion that all bearing metals should be purchased on their mechanical and physical properties, for the reason that these properties in the same metal may be decidedly influenced by the number of times the metal has been remelted, by the pouring temperature and the size and volume of the bearing. His opinion was based on the fact that the temperature at which a soft metal bearing is poured exercises a pronounced influence on the ductility of the metal, as is readily shown by the tensile strength, compression, hardness and wearing properties.

T. B. Lynch stated that his experience had been that if soft metal was poured at too low a temperature it crumbled under the compression test; when poured at 450 deg. C it showed good ductility, and when poured at a dull red the test would shear off with an angular break or crack and burst. He stated that his observations did not agree with the temperatures recommended by others, who advised pouring some six lead-base metals at 330 deg. C, and suggested that further investigation be made to determine the best pouring temperatures for the several classes of soft metals.

(The second section of this article, dealing with lubrication, will appear in the June issue.)

KILN DRYING OF GREEN HARDWOODS

Technical note No. 90, issued by the Forest Products Laboratory, United States Forest Service, points out the need for a mechanically perfect heating system in kiln-drying hardwood lumber green from the saw. The successful kiln-drying of such lumber requires a very even control throughout the kiln at all times, variations in temperature of even a few degrees or variations in relative humidity of 0.5 per cent seldom being permissible. Such uniformity is possible only when the heating coil is properly drained, is relieved of air, and is distributing heat uniformly along its length.

It is the contention of the Forest Products Laboratory that the return-bend heating coil system, by bringing about more uniform distribution of heat in the kiln, enables the operator to obtain quicker and better drying than is possible with the header-coil system as it is generally installed.

The return-bend heating coil gives practically an even heat distribution under any steam pressure. The header-coil produces different temperatures at either end of the kiln, the extent of variation depending on the steam pressure, length of coils, drainage, traps, etc.

Refractory hardwoods require low temperatures, and the lower the temperatures used, the more evident will be the difference in the results obtained with these two types of heating equipment. Under the same careful operation, green hardwood lumber may be turned out from kilns using the one type satisfactorily dried, and from kilns using the other type, over-dried at one end and under-dried at the other.

Freight Car Repairs on the E. P. & S. W.

An Outline of General Policies that Have Brought Results With Details of Some of the Work Done

BY A. M. DOW

General Foreman, Freight Car Repairs, El Paso & Southwestern

A practical review of the methods of carrying on the work in general on the El Paso & Southwestern as well as some of the detail parts of the work, may be of practical use to those in charge of the car departments of the railroads. Let us consider first the work of the light or running repair forces, who are working directly under one of the assistant general foremen of freight car repairs. The repair track inspector begins work 20 min. before the men every morning and carefully checks the bad order cards,

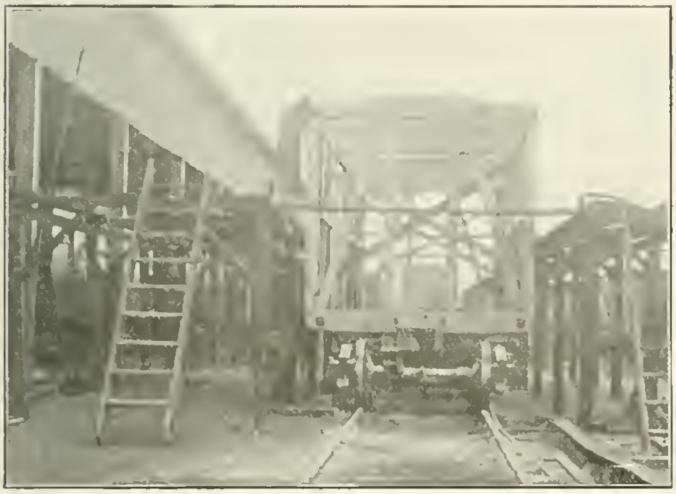


Fig. 1—Wooden Cars Completely Rebuilt On a Seven Hour Schedule

and inspects the cars to see that all defects are marked up on the cards as a guide to the men in working the car. One track is worked out completely, then the force works back on another track, and so on over the five different tracks during the eight hour period. A switch engine pulls off all cars that are finished at the noon hour, and at such other times as needed. So far as the light or running repairs are concerned, the methods in use are not very different from any other repair points, except that not more than two men are allowed to work on one job at a time. There is no necessity of more than two men for any light repair work, and, if more than two men are on a job, we find they are in one another's way to such an extent as to be a detriment rather than a help.

While this regular day's program is being carried out by one of the assistant general foremen and his force, the other assistant general foreman and his force are engaged in repairing the wrecked cars, heavy steel repairs, rebuilding and reinforcing old wooden equipment, etc. The two assistant general foremen change places every 30 days in order that each may keep in full touch with the entire force and all the different classes of the work. It is also found that the men remain at a higher point of efficiency through the change of supervisors.

Systematizing Heavy Repairs

To illustrate the method used in handling our heavy work it may be interesting to describe in detail the rebuilding of a series of 250 steel underframe wooden superstructure stock cars, which was undertaken and carried through at what we consider a very rapid rate, and at a very economical labor cost per car. The work was systematized in the following manner: A schedule was figured out composed of a series of individual operations. On each one of these operations were placed just enough men to perform that operation in a period of time which was previously determined upon as the unit of the schedule. In the case of this series of cars it was desired that one of these cars be turned out of the shop complete in every respect every four and one-half hours, which was done, at an average labor cost of $15.07 per car. The schedule was arranged as follows:

Gang No. 1. Four men stripped the superstructure of the car, removing all decking, all broken, decayed, or crooked posts, and side and end plates, in fact stripping the car completely.

Gang No. 2. Three men erected the framing complete, and applied all tie rods.

Gang No. 3. Three men applied the outside slats and roofs.

Gang No. 4. Two men applied the inside slats, running boards, doors, and safety appliances.

Gang No. 5. Two men did all truck and steel work.

Gang No. 6. Two men made side doors and did air brake work.

Gang No. 7. One man painted the car.

In all seven gangs with a total of 17 men turned out a complete car every four and one-half hours, at a labor cost of $15.07 per car. This is a record of which we were proud. It is true this work was done in 1915, and that the average wage paid per hour was 19.7 cents. The majority of the men could not speak our language, and, with the exception of three or four men, up to the time we hired them and placed them on this work, had never done car work of any kind.

After completing this series of stock cars the task of applying steel center sills and rebuilding a series of 82 all

Fig. 2—A String of Steel Underframe Cars After Rebuilding

wood box cars was taken up. These cars required new side sills, plates, posts, decking, all siding, etc. In fact, they were built entirely new from the sills up, with an inside metal roof. (See Fig. 1.) Seven hours was set as a schedule, with eight operations and a total of twenty-seven men, and this work was done at an average labor cost of $45.36 per car. Then followed the rebuilding of a series of 100 steel underframe box cars, shown in Fig. 2, which were put through on a six hour schedule. These schedules were

rigidly maintained, and a number of workmen were weeded out as the work progressed on account of not keeping up with the procession.

Routing Cars and Material

A word as to how the work was kept moving. All heavy work of this kind on which a schedule can be successfully

Fig. 3—A Badly Bent Sheet in the Flanging Clamp

used is laid out on repair tracks which open on a transfer table on one end and to the repair track lead on the other. The cars are brought in over the transfer table and started

Fig. 4 The Sheet Shown Above Fifteen Minutes Later

down the track. When the first operation is completed, the men move the car ahead one car length, and so on down the track until all operations are finished, when the switch engine removes the cars from the track and takes them to the paint track where painting and stenciling is done. The material used in each operation is conveniently placed for the gang on that operation to reach.

The secret of the success of the schedule plan lies in the fact that each man performs only one operation, and that one over and over again. As he gains experience and practice in performing that operation he begins to try to make it easier to perform, knowing that as he succeeds in doing so he also makes the work easier for himself, thus, unconsciously, speeding up the machine as a whole. The necessity of teaching a workman one operation only makes possible the use of inexperienced men on practically the entire job. Another gain made is that the different gangs will unconsciously promote rivalry by the exercise of that pride that exists in almost every man of not letting the other fellow beat him, thus each gang striving not to be last really keeps the whole moving smartly and rapidly. The schedule plan also helps out the labor situation in this day of shortage of mechanics, as it is our practice to use the experienced men

Fig. 5—Flanging a Floor Sheet in the Power Brake

on light or running repairs, and the less capable men on the work which can be placed on a schedule as just outlined.

Steel Car Repairs

The subject of heavy steel car repairs seems to be sidestepped by most of the car men who write for technical magazines, not because of its lack of importance for this is the most important work of the car department. Perhaps the subject can best be handled by giving a general description of some of the most important points. For instance, a side sheet of a gondola car is often badly bent and possibly rolled up by being cornered or wrecked. Experience has shown that the only way to handle a case of this kind is either to take out the entire sheet and straighten it cold on a face plate with clamps, or else cut out the damaged

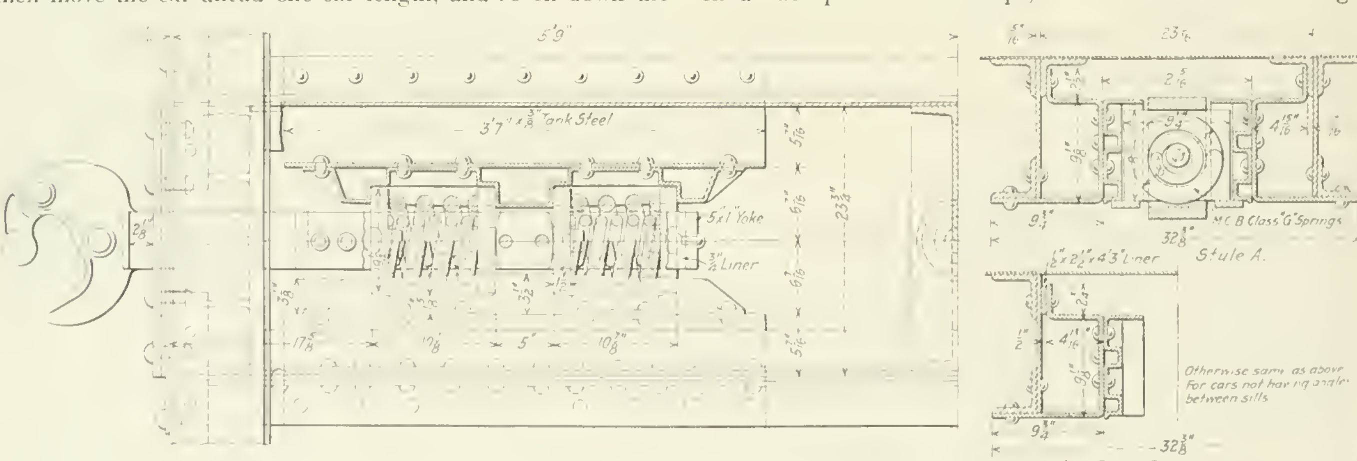


Fig. 6—Application of Tandem Spring Draft Gear on Center Sills with Wide Spacing

portion and put in a new piece by making a butt splice.

In any case when attempting to straighten plate steel such as is used in the floors, sides, and ends of a gondola car, *do*

not attempt to use heating appliances such as oil burners and torches, as the trouble will only be aggravated. These plates must be straightened cold on face plates, and by the use of powerful clamps, aided by a libeal use of hand power in the shape of heavy sledges. In Fig. 3 is shown

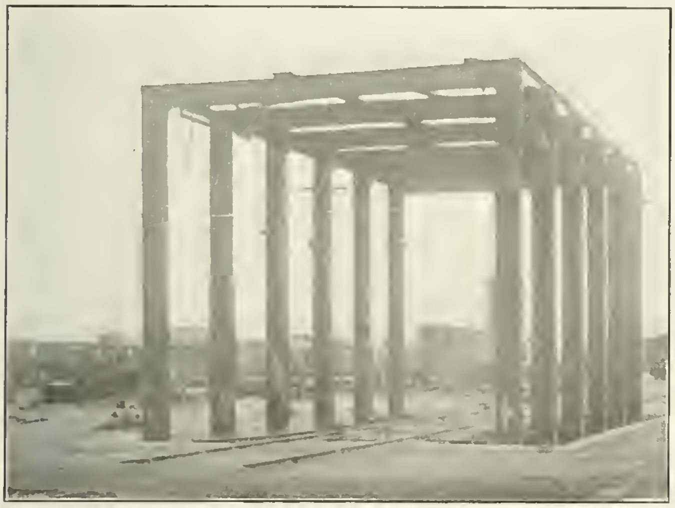


Fig. 7—Jacking Stall for Straightening Steel Cars

a clamp in use to straighten all parts of steel cars. This is in reality nothing but a boiler shop flanging clamp.

The photograph shows a badly bent side sheet of a gondola car in position in the clamp for straightening cold. Fig. 4 shows the same plate 15 min. later, having been straightened by the clamp, and three men with sledges, in that period of time.

In Fig. 5 is shown a bending brake on which it is possible to bend cold, to any desired shape, plate steel up to ¼ in. in thickness by 10 ft. long. In the foreground may be seen various shapes which have been formed cold on this machine. It has been found to be of great benefit in our steel car work. In the illustration the machine is shown in operation forming a floor sheet for a 40 ton steel gondola car, which is being put through the shop for new floors, the old floors being corroded and rusted through. In connection with renewing the floors in these cars it was found that the side sheets were also rusted through at a point just above side sill. In order to avoid applying new side sheets we used plate steel wide enough to flange upward on the side sheet

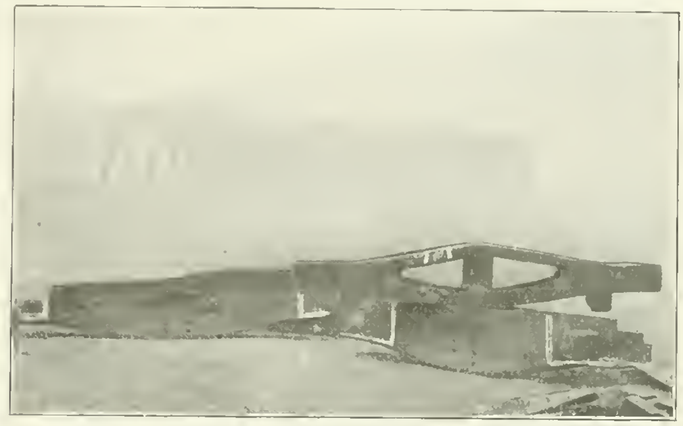


Fig. 9—Defective Bolsters Prepared for Welding

16 in. from the top of the side sill and riveted to the side sheet by a row of ½ in. rivets spaced 6 in. apart. This makes a very neat job, and also makes the side sheets just as good as new ones, as corrosion of the side sheets does not extend more than 6 in. above the side sill.

These cars were built in 1903 and the center sills were spaced 24 in. apart, and equipped with a twin spring draft attachment which was continually failing. To overcome this trouble it was decided to change the draft gear to the tandem spring type using the heavy type G spring. This was accomplished by applying a check plate made from ⅜ in. steel, as shown by Fig. 6. This has proved very satisfactory, and stopped draft gear trouble with this series of cars.

Frequently steel, or steel underframe, cars are found with

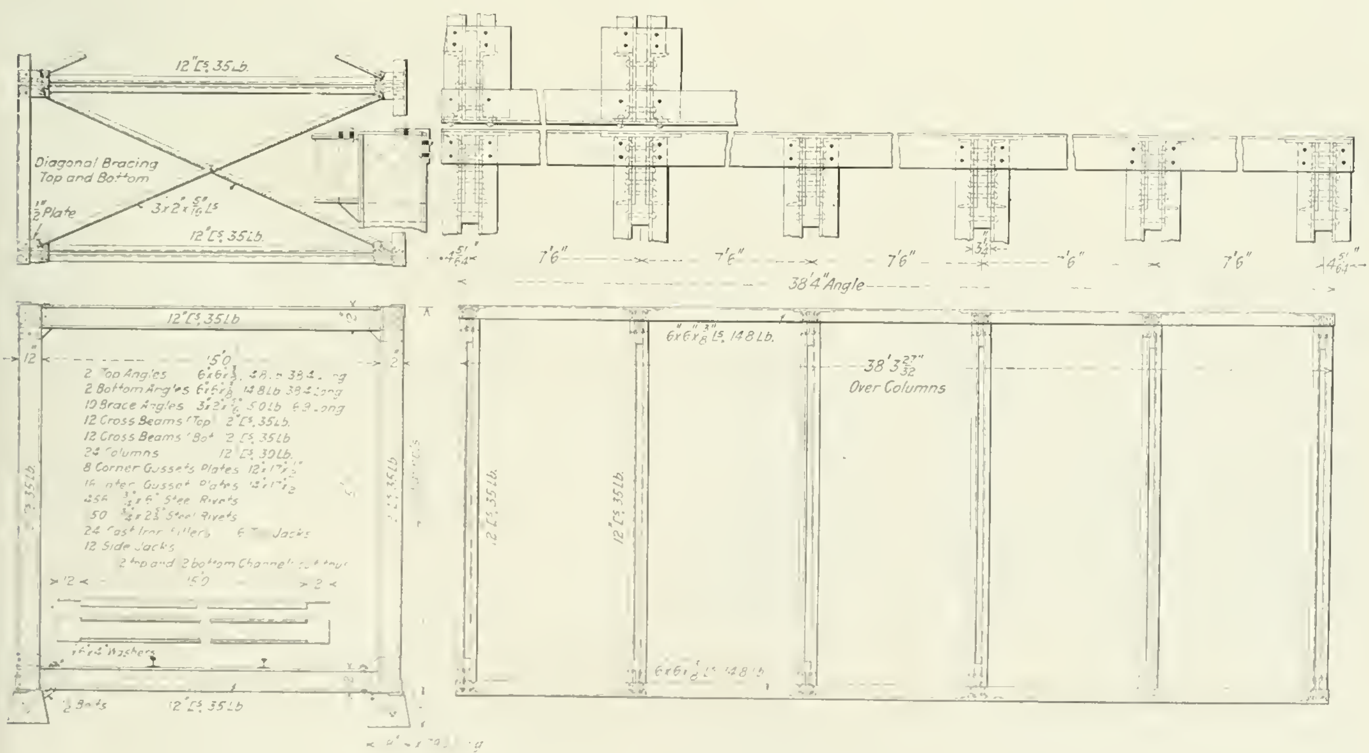


Fig. 8—Construction of the Jacking Frame

the center construction badly out of line, or the sides badly buckled. These cars are taken to the jacking frame, Figs. 7 and 8, where they are readily straightened without stripping. This frame can be constructed at a nominal cost, and will soon pay for itself in the economies effected. Jacks may be used at any angle desired, and from as many different angles, simultaneously, as one may see fit.

Some of the work done with the oxy-acetylene welding plant is shown in Fig. 9. Built up truck bolsters on which the ends have been worn through, are shown in the foreground. Enough of the bolster is cut out to remove all the worn parts, then new metal cut to fit the original contour is welded in. Cracked cast steel bolsters are welded and then patched over the weld.

Fig. 10—Part of the Equipment for Handling Steel Car Work

A part of our steel car fabricating machinery, forges, and face plates used in repairing steel car detail parts are shown in Fig. 10. Fig. 11 shows the nature of some of our steel car repairs.

Keeping the Output Up

The car plant, as reviewed in this article, and shown in the cuts, is capable of handling all repairs and rebuilding, as well as building new any equipment that might be needed on a road of the size of the E. P. & S. W., if efficiently handled, and efficiency is a matter that our supervisory forces must become more proficient in than ever in these days when mechanics are made by an order and perpetuated by an agreement. We must use every endeavor to get every return possible for the money spent for labor, ever remembering that any force of men will give results in direct proportion to the desires of their supervisors, and that, if any of our shop forces are not up to the standard output, or unit cost, the trouble is in their supervision, or something that the supervisor can correct. Do not put up that excuse which of late has become so popular, "The men will not do a day's work any more," but instead ask yourselves the question *why* they will not, and then proceed with the remedy. If the remedy is bitter, take it in small doses until you have effected a permanent cure, or else acknowledge to yourself that you are out of place as a supervisor and retire to a sphere where you are on common ground with your surroundings.

Fig. 11—Steel Cars Dismantled for Repairing

If above the need of a remedy, or having taken it, and are yourselves above reproach along these lines, then unite in condemning to your superiors the past practice of car construction to the end that future equipment may be constructed strongly and correctly, then protected from shocks by some improved shock absorbing device, instead of as in the past when the theory of constructing the different parts stronger each time new cars were built was followed so far that as a result at the beginning of government control we were constructing cars on the theory of a battering ram wherein the stronger destroys the weaker, and the poor car man was blamed for not keeping his equipment in service instead of requiring those responsible for design to properly design and *provide protection* from the shocks and rough handling they, as well as all of us, knew the car would receive when placed in service.

The thousands of cars built prior to about 1912 and put in service without any means being taken to protect them from the shocks it was known they would receive stand as a monument to prove that our practice has been wrong in the past, and our ways should be mended at once. We should take some of the remedy called "self analysis," and may possibly derive some benefit from a consistent course of this treatment.

PERIODICAL REPACKING OF JOURNAL BOXES A.R.A. RULE 66

BY CAR INSPECTOR

Numerous papers have been written on the subject of hot boxes, the causes and remedies therefor, and various methods of packing journal boxes have been introduced, but nothing has been offered which will eliminate the trouble entirely. Just as soon as an epidemic of hot boxes appears and trains are seriously delayed everyone on the railroad, from the president down, gets busy and the trouble is temporarily relieved. This would indicate that careful attention as to repacking and lubricating is necessary at all times. It has been clearly demonstrated that unless journal boxes are properly packed journals will not lubricate, resulting in heating of the brass. If not detected in the early stages of heating, the journal as well as the brass, wedge and in many cases the journal box also will be damaged to such an extent as to require renewal. An important duty rests upon the shoulders of the car oiler and just how well he performs his work can be very readily judged by glancing over the hot box reports.

Too much of the work of administering care to journal boxes has been left to the car oiler in the train yards and not enough attention given this class of work on repair tracks and in shops. M. C. B. Rule 1 requiring that the same attention be given foreign cars as the owner's cars has not been fully carried out in this respect and the fact that cars are away from home ofttimes two and even three years, renders necessary some action which will assure better attention for the foreign car. A. R. A. Rule 66 which makes the car owner responsible for periodical repacking of the journal boxes should be an inducement to care for the foreign car and if the work is properly performed in accordance with the provisions of this rule there is no question but what a remarkable improvement in the condition of journal box packing will be noted. It should be borne in mind, however, that the results which will be obtained, depend entirely upon the manner in which the work is done and the supervising force in the car department has an important duty to perform in carrying out the provisions of this rule. The practical value of all A. R. A. rules can be greatly enhanced by more care in living up to them.

The Inspection of Freight Equipment*

Air Brakes and Foundation Brake Rigging; Estimated Braking Power; Defects of Arch Bars and Trucks

By L. K. SILLCOX
Master Car Builder, Chicago, Milwaukee & St. Paul

To pipe cars properly is of vital importance to the desired action of the air brake. This, however, is a portion of the air brake make up which is occasionally neglected. Under no condition should the pipe be used without first being thoroughly cleaned. To do this the pipe should be lightly tapped to loosen the scale and dirt and then be blown out with steam or air. The sizes of pipe given in the air brake catalogues should in all cases be strictly adhered to. It will be noted that sizes of pipe given for freight cars are generally larger than those to be used on passenger coaches, as shown below. This is for several reasons.

(1) It will cause a more rapid reduction or increase of pressure at the rear portion of the train on account of air traveling through the large pipe more quickly; the larger the pipe the less friction the air will encounter in its passage through it.

(2) A freight car is considerably shorter than a passenger car, thus the large pipe makes the volume of air in the train more nearly equal to that in the smaller pipe used on the passenger coaches, which are longer.

When pipes are cut a flare or fin will be created in the inside of the pipe, considerably reducing its size; this in all cases should be carefully removed with a reamer. When too many of these are allowed to remain through the pipe system it will prevent the emergency action of the brakes. When using red lead or any other substance to make a joint, it should always be put on the outside thread or the thread to be screwed in, as this will prevent it from being forced into the pipe and causing defects in the brake system.

Whenever practicable, when necessary to change the direction of the pipe, it should be done by long, easy bends, instead of elbows or short bends, as the frictional resistance caused by these fittings retards the flow of air through the pipes. Care should be taken to have all the pipes rigidly clamped, so as to prevent vibration or moving, which causes the joints to leak or holes to become chafed in the pipes. After the pipe work is applied and completed it should be thoroughly tested under full pressure for leaks by use of soap suds applied to the joints, and later painted with rust-proof paint.

Cars will not be accepted in interchange unless equipped with air brakes having 1¼-in. air brake pipe and angle cocks, also quick action triple valve, pressure-retaining valve and an efficient hand brake.

Pipe Clamps

Pipe clamps should be checked at every opportunity both on repair tracks and in yards, to see that they are so placed and in the necessary condition to perform the work for which they were intended. They should be securely fastened to a rigid part of the car and should hold the piping firmly, prevent vibration and not allow the brake pipe to shift lengthwise if air hose are pulled apart, as happens in a break in two or when switching in the yards. Any missing jam or lock nuts must be replaced.

Air Hose

It is required that all air hose must be tested under air pressure with soap suds at every available opportunity whenever air pressure is to be had. This practically only applies to repair tracks, but much difficulty is experienced in the outside yards where a soap suds test is not practical, and therefore defective hose is hard to locate. Inspectors should be very careful in their inspection of hose on cars in the yards and should remove every one that shows an older date than 27 mo. if they do not consider it safe to proceed, and of course this only applies to hose which otherwise appear to be in good condition. Any of these hose that are removed on account of being old date should be forwarded to the main shop in the district so that they may be properly tested.

It should also be the duty of all inspectors to pick up all defective hose, regardless of the nature of the defect, and forward them to the general storekeeper. A great many of these defective hose, especially burst hose, will be found in cars and cabooses, and inspectors should make a periodical inspection of this equipment, so that they may know positively that there is no defective hose lying loose in their district.

At No. 1 and No. 2 inspection stations air hose must be tested with soap suds, and if found in a porous condition is to be replaced. Air hose gaskets must be kept in good condition, and when new ones are inserted the retaining groove must be cleaned out with the tool provided for that purpose. The opposite end of this tool, which is formed in a loop, is to be employed in seating the gasket in place. Air hose in service more than 27 mo. are generally in need of replacement.

Brake Cylinders and Reservoirs Loose on Their Supports

Whenever indications point to a cylinder and reservoirs being loose on their supports, or if any of the cylinder or reservoir bolts are loose or gone or lock nuts needed, repairs must be made at once, as movement of these parts causes brake pipe leakage and breakage. When brake cylinders and reservoirs are to be tightened on their supports, run up two or three of the nuts only far enough to bring the bolting flange into light contact with the supports. Then, with the bolting flange in contact with the supporting brackets at each hole, line up with cut washers where required. A failure to do this will result in springing and cracking the auxiliary reservoir and springing brake cylinders out of round.

A great deal of difficulty is experienced on account of reservoirs breaking away from cylinders and holding brackets on cylinders and reservoirs breaking off. While the class of supports used on many cars in service is at fault, the majority of the difficulty which is being experienced could be overcome if a little more care were taken in drawing up the nuts of the supporting bolts. It is common to see the men draw the nuts up until the cylinder and reservoir are in full contact with the support, thereby bringing an undue strain on the equipment. If where the supports are out of alinement the carmen were instructed, before tightening the nuts, to merely draw the reservoir up until the bolting flange was in light contact with the support and then line up with cut washers whenever necessary, the danger of breakage would be lessened considerably.

Triple Valves

There are six types of triple valves in general service, namely the Westinghouse, H-1, H-2, K-1 and K-2 and the New York F-1 and H-2. All of these valves work in con-

* Fifth of a series of articles on this subject by Mr. Sillcox.

junction with one another and are interchangeable to the extent that the H-2 Westinghouse and New York can be applied to a car that formerly had the K-2, but the H-1 Westinghouse and F-1 New York could not be used in this instance as one is a ten-inch valve and the other is an eight-inch valve. Otherwise there is no difference in the working of the valve.

Brake Rigging

Brake heads and brake shoes should be carefully inspected to see that they are in good condition and keys properly in place. Should brake shoes be worn out at either end permitting the head to wear against the wheels, the brake shoes should be renewed. When brake shoes are worn irregularly they should be reversed to obtain the maximum service from the metal in the shoe.

Brake hangers should be inspected at the brake head to see that they are not worn, making them unsafe; this should also apply to the hanger at the truck connection, to see that the hook or eye are not worn to the unsafe limit. Brake wheels, brake ratchet wheels and brake ratchet pawls should be inspected to see that they are properly retained in place when repairs are being made and careful inspection is to be made to see that they are properly maintained. Bolts and pins used in connection with hand brakes should be in place and properly secured.

Adjusting Brakes

After checking up piston travel if it is found necessary to re-adjust the brakes, the first thing to be done is to close the cut-out cock in the crossover pipe and bleed the auxiliary reservoir, this to prevent injury. The adjustments must be made so that the live truck levers on both sides of the car travel the same distance, to insure an equal distribution of braking power. With the brake applied, the foundation brake rigging should be inspected to see that all levers have ample clearance in their guides and elsewhere to prevent striking or binding with 12 in. piston travel, that all cotter keys are in place and points well spread, that hangers and dead letter fulcrums are secure, that the brake levers are standard, that rods are not being cut by axles, and that the rigging in general is in good order.

Before making any changes to provide lever clearance, insure that the length of rods and guides and the location of the latter are standard for the car. Whenever inspecting cars, inspectors must make sure that the brake rods are not riding on the axles thereby making them liable to break on application of the brakes.

Piston Travel

By piston travel is meant the distance the brake cylinder piston moves out when the brake is fully applied. To measure piston travel first be sure that the head is bottomed in the cylinder, making a mark on the piston rod at the edge of the cylinder head and then note the distance the piston travels out when the brakes are applied. Standing travel is the distance the piston is forced out in an application of the brake upon a car when not in motion. Running travel is the distance the piston is forced out in applying the brake upon a car when in motion. The running travel is always greater than the standing travel, the increase due to slack in loose fitting brasses, to the shoes pulling down on the wheels, to play between boxes and pedestals and to everything of a similar nature that increases lost motion in the brake rigging under the influence of the motion of the car. False travel is an excessive travel momentarily occurring while the car is in motion. It is due to unevenness of the track or to some unusual temporary strain.

The brake cylinder pressure resulting from a common train pipe reduction is greater with a short than with a long piston travel. A piston travel of eight inches results in a brake cylinder pressure of about 50 lb. in a full service application. Inasmuch as running travel is generally about 1½ in. greater than standing travel, the standing travel should be 6½ in. to secure this result while running. If the piston travel is shorter than eight inches, the auxiliary and brake cylinder air will equalize at a higher pressure and the brakes will be applied much harder. If the travel is more than eight inches, the auxiliary and brake cylinder air will equalize at a lower pressure and the brakes cannot be applied nearly as hard.

Brake Leverage

Ability to figure brake leverage is an accomplishment for an air brake man, not always a necessity, but it is well to know something about it. The different kinds of levers and the manner in which they operate should be learned first. A lever of the first kind has the power applied at one end, the weight to be moved at the other end and the fulcrum in the center. The cylinder lever connected to the push rod and top rod is a lever of the first kind.

A lever of the second kind has the power applied at one end, the fulcrum at the other end and the weight to be moved is between them. The live truck lever of an outside hung brake is usually a lever of this kind.

A lever of the third kind has the power applied between the ends. A lever of this kind takes more power in proportion to the weight to be moved than either of the other kinds. This lever is very rarely met with in the present construction of freight cars.

When measurements and calculations of brake power are made, the greatest care must be exercised in measuring, as a mistake of a very short distance on the short end of a live lever will alter the power considerably.

Beginning at the brake cylinder where the power is first exerted, the power must be ascertained, which is done by multiplying the area of the cylinder piston by the pressure per square inch. The result of an eighth-inch cylinder is 2,500 lb. and a ten-inch cylinder, 3,900 lb. This value is then multiplied by the distance from the push-rod connection to the fulcrum, which is in the center, this lever being of the first kind, and this product is divided by the distance from the fulcrum to the top-rod connection. This will give the pull on the top road, which is transmitted to the top of the live truck lever, usually a lever of the second kind. This pull is next multiplied by the total length of the live truck lever and the product is divided by the length of the short end, which will give the strain on the brake beam. This multiplied by the number of beams will give the total braking power. To determine what per cent the car is braking the total braking power is divided by the light weight of the car. Cabooses should brake approximately 45 per cent of their light weight, other freight cars 60 per cent.

Both cylinder levers, or cylinder and floating lever, need not be of the same length, but they must be of the same proportion to insure getting the same braking power on both ends of the car.

Brake Levers

When necessary to apply a new lever to a system freight car the proper dimensions of the lever wanted must be ascertained positively in order to provide the proper braking force to the wheels. The dimensions of the various levers for the several types of cars are clearly shown on blueprints and must be closely followed.

Lever Pins and Cotter Keys

The greatest care should be exercised at all times to know that lever pins are properly in place and cotter keys applied and properly opened to prevent the pin being jarred out, which would cause a brake rigging failure and probably a derailment, especially if it occurs in the bottom rods. Lever

pins should be placed in from the top whenever possible, as this will provide a certain amount of protection in case the cotter key works out. Brake beam hanger pins also should be checked over closely to ascertain whether the pin by continual friction is worn through and liable to break at any time. It would be good policy, whenever possible, to have brake hanger pins removed for inspection, as investigations disclose the fact that a great majority are about half worn through. At any rate, inspectors and repair men should check them very closely, as there is nothing that tends more to cause derailments than brake beams coming down.

Cotter Pins, Split Keys and Nuts of Brake Hanger and Connection Bins

It should be remembered that these parts must be placed with the heads inside or under, so as to make the retaining cotter pin, split key or nut visible from a passing inspection, and not make it necessary for inspectors to climb under the car to note their condition.

Brake Beams

The dimensions and proportions governing the hanging of brake beams are as follows: The height when measured from the top of the rail to the center of the face of new shoes is: For inside hung brake beams, 13 in.; for outside hung brake beams, 14½ in.

The spacing from center to center of brake heads is 60 in., with an allowable variation of ⅛ in. in either direction. Attachments for safety hangers shall be 51 in. from center to center.

The angle of the lever fulcrum shall be 40 degrees from the vertical.

The lever pin hole shall be either two or three inches in front of the top of the brake head lugs. The variation in either direction from straight and true shall be not less than 1-5/32 in., nor more than 1⅛ in. in diameter.

Safety Hangers

It is required that all brake beam safety straps on car trucks shall be of such depth as to allow but ¾ in. between the straps and the bottom of the brake beam when the brake shoe is ⅜ in. from the wheel, and of such length that no part of the brake beam will strike the strap when the brake is applied with all shoes worn to a minimum thickness. It is also required where angle iron brake beam safety supports are employed that not to exceed ¾ in. clearance is to prevail between the bottom of the brake beam and the top side of the safety angle.

The capacity and strength of the number one beam is suitable for cars weighing less than 35,000 lb. The number two beam to be used on cars weighing over 35,000 lb., although it is permissible to use the number two beam on cars weighing less than 35,000 lb. Right and left-hand brake beams are designated as follows: When facing the back of the brake beam with the center strut pointing away from the observer, if the top of the lever slot inclines toward the right it is known as a right-hand beam, and if the top of the lever slot inclines toward the left it is known as a left-hand beam.

Brake Shoes

It should be borne in mind that at each application of new brake shoes the piston travel changes. Therefore, whenever new shoes are applied to cars the piston travel should be checked up accordingly.

Hand Brakes

In checking up cars before leaving repair tracks and yards, it should be known that all hand brakes are released, for if cars are allowed to leave with the hand brake set there is a liability of slid flat wheels, or at any rate overheated wheels, and the eventual possibility of bursting. Also, it should be noted that the hand brake rod and chain are not too long. They should be of such dimensions as to insure a full application of the brakes with the use of the hand wheel. The chain must not catch on the staff support and rods, levers, etc., and must be free from any interference that would prevent the delivery of full hand brake force to the brake shoes. Brake chains or rods must not bear against any part of the axle, causing chafing and wear.

Hand Brake Staffs

Hand brake staffs must be made of one piece; welding of two or more parts together is not permitted. The standard maximum height of the brake staff for standard box cars, from the top of the rail to the top of the brake staff, is 14 ft. The portion of the brake staff on which the brake chain winds must be of such length and so located as to permit winding the amount of chain resulting from 12-in. piston travel without "piling up" or overlapping.

The dimensions of the brake chains should be, for the first link that fastens on brake staff, ½ in. diameter, 2 in. long, and 13/16 in. wide inside. For the succeeding links, 7/16 in. diameter, 1¼ in. long and ⅝ in. wide inside measurements. This chain is attached to the brake staff with a ½-in. bolt, which is riveted over after the nut is applied.

Hand brakes must be known at all times to be operative and effective; a failure of this appliance constitutes a violation of the federal laws, therefore proper inspection and maintenance are absolutely necessary.

Running Repairs to Trucks

It seems to be the general experience that there is a great deal of trouble, due to failures of truck frames on account of nuts missing from box pedestal jaw and column bolts, and in many cases it is necessary to apply new bolts on account of the worn or otherwise damaged condition of the threads. It is also found that on practically all types of trucks a great many brake hanger bolts and pins are found that have no spring cotters, split keys or nuts to hold the bolts or pins in place, the result being that the bolts or pins fall out of the hangers and allow the brakebeams to drop; also, the hangers and pins are allowed to become worn to such an extent that in their weakened condition they fail. Care must be exercised in examining brake hangers to see that flaws in forgings do not exist, also that the brake heads are not worn beyond the required limits.

Another point is that a large percentage of the brakebeams in service have no safety device for holding them in case the hanger or pin should break, with the result that it is found necessary to employ extra men in the yards to watch these important features of truck inspection and maintenance. On account of the great amount of this work in large terminals, it appears that generally some stations are not giving all the attention that they can to maintaining these essential parts of trucks while passing through their hands, the result being that extra work is placed upon their neighbors.

The matter of truck maintenance should be taken up vigorously by all supervisors and the attention of inspectors and repairmen called to seeing to it that the nuts on oil box, pedestal jaw and column bolts are all applied and kept tight and also that the brake hanger bolts or pins are equipped with a suitable lock nut, spring cotter or split key. The failure of these parts is causing much trouble, and no reasonable expense should be spared in properly maintaining them.

Investigations carried on from time to time have developed that after the removal of brake hangers and pins from a number of cars they were found to be about half worn through. It is apparent that these parts have been in service for a long time and that they are very rarely, if ever, inspected except when brakebeams or hangers fail. It is a paying practice, whenever cars reach repair tracks, to have all the brake hanger pins and bolts removed for inspection and renewed when found necessary.

With this end in view, therefore, a system should be in-

augurated at all stations whereby all cars reaching repair tracks will have the trucks carefully locked over and the renewal made of any parts showing undue wear. Particular attention should be given to the column and oil box bolts and nuts—in fact, it should be our purpose not to allow any car to leave a repair track without the trucks receiving a thorough going-over and being put in good repair.

For system cars the standard brakebeams furnished are equipped with three openings, namely, for the pot hook hanger, for the intermediate stirrup type hanger and for the center supervision hanger, with the thought that the brake hanger can be changed in case the pot hook eye is worn, thus avoiding the necessity of having to change the entire brakebeam. It is further desirable to see that nuts on tension rods of brakebeams are kept properly locked in place and tightened.

Defective Arch Bars and Truck Frames.—Permissible Methods of Welding and Repairing.—Arch bars should be inspected for cracks, especially in bends. This may be more effective after first giving the edge of the arch bar several taps with the inspector's hammer to loosen up rust at cracks and flaws, which can then be more readily detected. Seams and flaws are usually found at the bends and at column bolt holes, especially at the bottom of the column post on the edge of the arch bar. Arch bars should not be welded in the bend or at bolt holes or between the journal box or column and box bolt holes. Trucks with cast steel side frames, such as Bettendorf, Andrews, Vulcan, Scullan, Ajax and others, should be gone over carefully to discover flaws or cracks that might exist which would endanger their safety. The same tapping with the hammer as on arch bars should be required on cast steel side frames. These frames are not considered safe for service when found cracked or with flaws more than *one inch back from the edge of the frame.* Such frames should be repaired by welding with oxy-acetylene or with electric welding apparatus, or they should be replaced with a new casting.

The fact that so many cast steel side frames and cast steel bolsters are failing in the tension (lower length of the truss) members is conclusive evidence of weakness in design, and the welding of the fractures will not add to the strength but is likely to introduce a condition of further weakness by improper workmanship and change in the structure of the metal. It is, therefore, necessary to confine acetylene or electric welding within specified limits on structures, subject to alternating stresses, as experienced in truck side frames and bolsters. The parts which are to be repaired must not be welded unless removed from the car or truck. Truck bolsters, however, may be welded in place by removing the truck from under the car body. The entire crack should be burned or chipped out far enough back so that there will be no portion of the crack in the metal. Failure to do this permits the check or crack to work its way across the metal to the farther side, due to the constant vibration, even after the weld has been made. A hole may be drilled at the end of the crack or check and chipped or burned towards the hole. The surfaces where new material is to be deposited must be clean and bright and reasonably smooth, and therefore if surfaces are prepared by the burning process the surfaces must be finished by chipping or welding. The portion of the part adjacent to the fracture should be heated before the welding is begun. In welding, the operator should begin to weld at the point farthest away from the outside edge and work the weld towards the edge. When truck sides and bolsters are welded, the weld must be made smooth and the following record legibly stamped on the weld with at least ⅜-in. steel stencils in the following form:

No.......... Day .... Year.......... Road...........
Shop Symbol.................... Welders No............

Truck bolsters and spring beams should be carefully inspected to see that they are secured to place properly and are not cracked or broken, making them unsafe for service.

Arch Bars and Truck Frames Bent

Derailments and other classes of road failures often cause trucks to be allowed to go into service temporarily with arch bars and frames bent laterally in the center; this is not only dangerous but a regrettable practice.

Side Bearing Clearance

Side bearing clearance should be carefully observed on cars with metal body and truck bolsters. When balanced on center plates it is considered good practice to have clearance of 1/16 in. to ⅛ in. between all four side bearings. If they are bearing hard on one side the total clearance should not be more than ¼ in. on the opposite side. On cars with wood body and truck bolsters, or composite wood and metal bolsters, it is considered good practice to have ⅛ in. to ¼ in. clearance between all four side bearings.

Care of Journal Box Lids

Lids on journal boxes should be lifted to make inspection of the sponging, journal bearings and journal bearing wedges to see that they are in proper condition, and journals not cut. Journal bearings and wedges should be in proper position in the box and sponging in place well to the back of the box and up under the journal. Box lids should fit well in place and be properly secured to exclude dirt and dust.

Truck Brake Rigging

Brakebeams, brakebeam connections and brake hangers should be carefully inspected to see that they are in good condition, with brake connection pins in place and cotter or split keys properly applied and opened. Brake levers and lower brake connecting rods are to be inspected to see that they are in good condition and the brake pin cotters split.

Brake heads and brake shoes should be carefully inspected to see that they are in good condition and the keys properly in place. Should brake shoes be worn out at either end permitting the head to wear against the wheels, the brake shoes should be renewed. When brake shoes are worn irregularly they should be reversed to obtain the maximum service of metal in the shoe.

Brake hangers should be inspected at the brake head to see that they are not worn, making them unsafe; this should also apply to the hanger at the truck connection, to see that the hook or eye are not worn to the unsafe limit. Brake shoes which are broken away or not safe must be replaced, and shoes unevenly worn must be turned. Brake shoes must be properly located and in place and not allowed to ride on the flange of the wheel. Brake shoes showing signs of being burnt red must have the brakes on such cars tested for proper operation and wheels examined for heating cracks.

Hand brakes should be tested to see that they are in operative condition and the brake chains not too long to prevent fouling when brakes are applied. Brake chain links should not be less than ⅜ in. in diameter at any point.

The brake wheel, brake ratchet wheel and brake ratchet pawl should be inspected to see that they are properly retained in place when repairs are being made, and careful inspection is to be made to see that they are properly maintained.

Cars built after October 1, 1914, and prior to January 1, 1917, will not be accepted in interchange unless equipped with either the No. 1 or the No. 2 M. C. B. brakebeam, as indicated by the light weight of the car; the No. 1 beam must not be used on cars having a light weight in excess of 35,000 lb. Cars built after January 1, 1917, or cars receiving general repairs after October 1, 1918, must be equipped with metal brakebeams of not less than the capacity of the No. 2 M. C. B., or stronger, as the conditions may require.

All of the M. C. B. brakebeams referred to shall have the letters "M. C. B." and proper number plainly stamped or cast on the strut, as required by the specification.

After October 1, 1920, cars will not be accepted in interchange unless equipped with all metal brakebeams.

SHOP SCHEDULING VS. OLD-FASHIONED METHODS

BY SUPERVISOR

The question is often asked, "What is the difference between running a locomotive repair shop with a schedule system or in the regular way as usually done?" It may be answered as follows:

The old-fashioned method of getting output from a railroad shop was to bring in engines until the shop was as full as possible. In a transverse shop with 25 stalls, two small engines were placed on some stalls, blocking or cramping the passage ways at the front and rear of other engines, crowding in, say 35 engines.

> Shop men frequently complain that locomotive output is limited because of a lack of pits. The author of this article thinks the fault lies elsewhere.

In a longitudinal shop with accommodations for 25 engines on two outside tracks, five or six engines would be put on the central or wheeling and transfer track, blocking the passage of wheels and engines going out. Also engines are crowded in so closely together on all three tracks that spaces between them are narrowed or closed entirely. Probably there would be 35 engines in this shop also.

The next step was to date the completed engines out and begin repairing those shown to go out first. Soon a cylinder is wanted, or a steel deck casting, or some unusual part, and these are not found in stock. This engine is then abandoned for the time being and the men are told that another more promising engine will come ahead and all hands go to that engine, transferring tools, material, etc., and they all take plenty of time to make notes and begin over again, studying the needs of this new engine. Material must be hunted up, and in some cases material from the first engine which is bolted to the lathe or planer is taken off and other material for the second engine substituted. Perhaps another switch is made from this second engine on account of delayed material, a welded frame tongue in the smith shop, a new link in the machine shop or heavy boiler work develops. In like manner possibly every other engine in the 35 undergoes a similar process of being worked on for a while and later deserted.

To sum up the situation, the unsystematic, inefficient shop superintendent gets what he can out of his shop, full to overflowing with engines and material. The men and supervision are demoralized. There is no penalty except tempestuous talk and driving for not getting an engine out on the date set; simply pick another good one and get that. The higher officers are continually disappointed; they expect a certain engine out on a stated date and don't get it. This old-fashioned organization with 35 engines on 25 pits in the shop finally succeeds in delivering 25 engines with classified repairs by the end of the month. This means an output of one engine per pit per month, or, based on 35 crowded pits, 7-10 of an engine per pit per month.

Now a railroad repair shop is, or should be, as carefully designed as a Mallet engine. A Mallet will give its maximum drawbar pull with minimum steam consumption, at a working speed of about 15 miles per hour. Likewise a modern railroad shop will, at the present time, deliver its maximum output at the rate of about two engines per pit per month, with minimum cost and minimum labor and machine effort. But how about the shop delivering 7-10 of an engine per stall per month? It is not possible, unfortunately, to figure accurately the cost and lost time and labor resulting from an output ratio of this low figure.

Let us now consider the modern shop operated with the assistance of a complete scheduling system. Engines are thoroughly inspected before being brought into the shop, and all material needed is on the ground, not simply on requisition. The policy of the management for this shop is to allow the shop superintendent to bring in engines at his discretion, and the line-up is not dictated by some higher officer. Twenty-five engines, inspected and chosen for properly balancing the work of the shop organization, are then brought in on the 25 pits available and exactly in accordance with the space designed for placing engines when the shop was built. Dates are then set for these engines to go out completely repaired and every operation and all important material is scheduled to be finished at certain proper times in order to erect the engine in the most orderly and systematic manner. The output is figured at the low estimate of 50 classified repairs for the month, or two engines per stall or pit.

Now comes the most important feature of this properly operated shop. When an engine drags for some reason, the cause is sought out and immediately remedied and those responsible for the condition are penalized with red delay marks on the schedule office boards and the daily delay sheets advertise to all superiors and supervision the department which is deliquent and the cause. What is the result? Foremen are not pleased with this situation, and take steps at once to line up their material and forces to rectify it. No man with any ambition at all wants to be known as a slacker or as having "fallen down" on his job and caused others to be late and censured. Men are not shifted from this late engine as was done in the old-fashioned shop. This

would be the easiest way out and following the line of least resistance, but the most costly way in the end, as is always the case through life. Everyone is stimulated by the supervision, including the shop schedule supervisor, to appreciate their responsibility for meeting the promises made to superiors for the delivery of the engine on time. Consequently they all "go to it" with energy and a quiet determination to overcome the obstacles speedily. Responsibility is the greatest sobering influence, and a proper sense of responsibility is what we need in our shops today.

The primary beneficial result from these up-to-date methods is character development. The shop superintendent and foremen and all the way through the ranks, begin to realize and understand that when an engine is scheduled out, that settles it, and the engine must be worked on continuously and faithfully until it goes out, barring the most unforeseen reverses, even if a week late. Gradually the general status of the whole shop is raised, the morale of the supervision and men improved and a desire to win stamped on every mind. This spirit and desire for honest orderliness and conscientious work is the only known condition through which a shop may be developed to produce the output for which it was designed. It is admitted, of course, that adequate machines and organization are first installed. Shorter hours, abolition of piece work and social unrest have their influences, but fundamentally the above discussion is logical and conclusive.

SALVAGING HIGH SPEED STEEL SCRAP

BY SAMUEL S. BUCKLEY

The process used by the Onondaga Steel Company for reclaiming high speed steel scrap is based on a careful selection and grading of the material to be reclaimed. To be successful, the converter of high speed steel scrap must return to the customer a steel that is as good if not better than the original high speed steel, and it is not wise to endeavor to produce any other than the required standard. The converter must be guided in his action to a great extent by the type of steel submitted, the larger proportion of which will contain 18 per cent tungsten, about 4 per cent chromium, approximately 1.20 per cent vanadium and carbon between .60 and .70 per cent. Being held to the standard type, he has no opportunity of improving this steel by a change in composition.

The converter of high speed steel scrap has had to overcome the notion that because scrap is used as a base the steel produced must be of inferior quality. Satisfactory results have been attained, however, only by the use of extraordinary methods in the selection and proportioning of new material, and extreme care in handling it through all the steps of the process. The idea that only scrap is used in melting is erroneous. No matter how carefully tested and selected the scrap may be, new additions of muck bar, tungsten, chromium, vanadium, etc., must be made to "sweeten up" the melt, as a steel maker would say. If high speed steel scrap were melted without this sweetening, the resulting material would have lost some of its elements, particularly vanadium which is quite volatile, and it would be apt to show shortness or brittleness, possibly from the same reason that cast iron becomes more brittle each time it is melted over. The scrap received is separated into either first, second and third class, or is rejected.

The first class comprises high speed steel scrap containing 15 per cent tungsten or over. The second class consists of scrap with between 15 per cent and 12 per cent tungsten. The third class, which has some value, though hardly worth converting, consists largely of the old-fashioned self-hardening or mushet steel.

Rejected material consists principally of the straight carbon tool steel and odds and ends of ordinary soft steel and discard that would ordinarily be classed as junk. In these rejections are included drills, reamers and other tools with soft steel shanks, oil tube drills having copper or brass oil tubes, tools that have shanks or parts brazed or soldered upon them. Tools with soft steel shanks can be partially reclaimed by breaking off these soft steel parts well into the high speed steel. The reason for the rejection of the above mentioned soft steel parts is due, of course, to the fact that they are usually made of nickel steel, and nickel as well as copper or any other non-ferrous metals are absolutely tabooed in high speed steel, therefore the maker dare not chance the addition of even a small percentage of any of them.

The Spark Test

In order to develop an absolutely uniform material from the miscellaneous scrap sent in, it is necessary for every piece to be tested by some quick, economical and reliable method. It was found after much experimenting that a spark test was the most satisfactory.

For the testing of high speed steel scrap, assuming that it is free from the metals or soft steel parts referred to, it is necessary to have a soft free cutting alundum or corundum wheel running dry, at a speed given by the maker, and located in a dark place so that sparks may show to the best advantage. The spark test is based on the fact that each separate grade of high speed steel develops a characteristic spark by which it can be identified under these conditions. To conduct this test the operator should take samples of steels of known quality and thoroughly familiarize himself with the different sparks shown by them when in contact with the wheel. The color, shape and length of the spark stream should be carefully noted. These sparks will show a dull red stream 0 to 20 in. from the point of contact with the wheel, at which point there is an explosion or opening up of the spark stream. Some high speed steels show a bright star effect, while others break up into lines similar to but brighter than the line running down from the point of contact. Experts can pick out most of the various standard makes by the difference in sparks. This can only be done, however, by experts who have made this a deep study and who are continually in practice.

Take, for instance, the old-fashioned mushet type of self-hardening steel. This throws off a spark very similar to high speed steel with a stream that has a slight tendency to open up at the end but not into what might be termed an explosion. It is interesting to try the spark test on ordinary gray iron, as this resembles very nearly the spark of the old-fashioned mushet steel. It is not unusual, in fact, to receive gray iron on the assumption by the sender that it was tungsten steel.

The American self-hardening steel shows a brighter spark stream and a still brighter explosion than the mushet steel, and can be distinguished from high speed steel by the length of the spark stream and the difference in the color and size of the spark or explosion at the end of the stream.

The molybdenum self-hardening steel, a great deal of which was placed on the market just previous to the advent of high speed steel, shows a spark much brighter than high speed steel but of a character peculiar to itself — not having the brighter scintillating spark of carbon steel, but ending in a long stringy, comet-like explosion at the end of the spark stream.

There are several grades of self-hardening steels made for wood cutting, nail dies, etc. These all show a lighter spark, being low in chromium and tungsten. Then follows the double special or finishing steel, which shows a considerably brighter spark and a lighter red stream. There are some one and two per cent tungsten steels for tools on the market.

Any type of simple steel, such as tool steel or any ordinary soft steel of whatever character or shape, as well as nickel steel, can easily be recognized by a bright spark stream and brilliant scintillating spark explosion.

Squaring the Frames of French Locomotives

Special Gages Aid in Squaring the Locomotive Frames and Lining the Driving Box Shoes and Wedges

BY MAJOR C. E. LESTER
Formerly Gen. Supt., 19th Grand Division, A. E. F.

In overhauling French locomotives at Nevers shop, France, it was customary to remove the boilers and cylinders from the frames and, after stripping off all braces, lugs, shoes, etc., to give the frames a thorough cleaning and careful inspection for defects. A view of a pair of cylinders and frames just unwheeled is shown in Fig. 1. Frequently the frames were sent to the smith shop for repairs, and in their reapplication or in the application of new ones, the squaring gage, Fig. 2, was used. The purpose of this gage was to assist in squaring the frames with the cylinders and with each other, and to check for frame distortions.

It may be explained that frames on the smaller French locomotives are of the slab type about $1\frac{1}{2}$ in. thick and the driving box shoes are bolted to the frame jaws by a suitable number of taper bolts as indicated in Fig. 3. The driving box wedges are provided with tongues which fit into

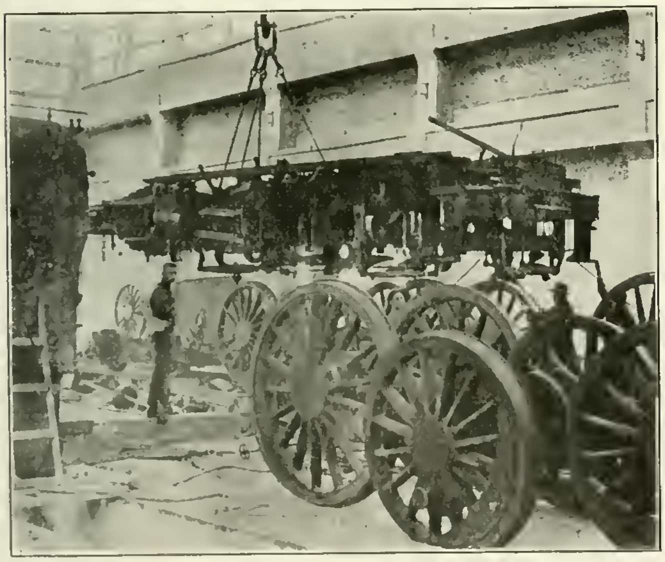


Fig. 1. French Locomotive Cylinders and Frames Just After Being Unwheeled

corresponding grooves in the female shoes, the latter also being bolted firmly to the frame jaws. The above arrangement of the shoe and wedge also is shown in Fig. 3.

When a locomotive was ready to be reassembled, the frames were bolted to the cylinders and the braces bolted up. The cylinders and frames were adjusted by means of jacks until level, as indicated by the spirit level. A string passed from the center of the cylinder to the rear of the frame was adjusted until exactly in the prolongation of the center line of the cylinder, and any offset in the frame could be detected by measuring the distance between the frame and the string. If there was a slight offset at the rear, due to a bend in the frame, the frame was left alone and bent back into position after putting the boiler in place. Reference to Fig. 4 shows blocks of wood placed midway in the jaws, which acted as a rest for the squaring gage (Fig. 2). The latter was placed so that the gage arm could swing on the outside, the gage beam extending through the frame from jaw to jaw. The sleeve shown was slipped on over the gage beam and held in place by a set screw. With the sleeve held against the frame jaw, the gage could not slide back in adjusting the set screw.

To square the frames the set screw was adjusted until, with the gage arm swinging, the end of the screw just touched the string. After being adjusted for the back jaw, the gage was moved to the main or front jaw without changing the screw. The gage arm was swung, and if the screw touched the string no adjustment of the frames at that point

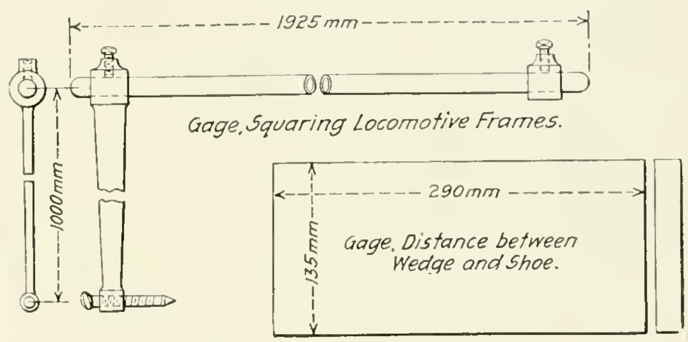


Fig. 2. Gages Used in Lining and Squaring Frames

was necessary. If, however, the screw did not touch the string it was necessary to move the frame one way or the other or to shift the cylinder by means of jacks. Occasionally, with new cylinders it was necessary to remove them and have a little planed off.

After using the gage on one side of the frame it was applied to the opposite side in the same manner as described above. The frames were adjusted until, without changing the screw adjustment, its point just touched the string when

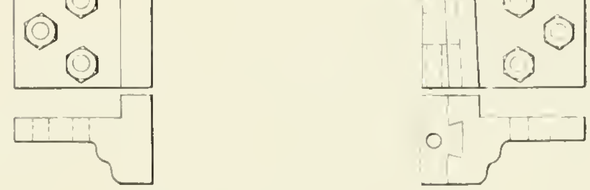


Fig. 3. Shoe and Wedge Arrangement

the gage was used on either side of the frames or at any pair of jaws. With this condition fulfilled, the frames were considered square. The spirit level was again tried, to be sure that the cylinders as well as the frames were level and had not shifted.

Driving Box Shoes

Before bolting on a driving box it was necessary to have the correct distance between the wedge and the shoe. This

distance was obtained by means of a rectangular gage, illustrated in Fig. 2. The gage shown was used for the 4,000 class locomotives and other gages of a similar type were provided for the other classes. When the wedge had been fitted to the female shoe, the rectangular gage was placed against the wedge and a distance of 40 mm. equal to the shoe width measured in excess of the 290 mm., representing the driving box width. This indicated the proper position in which to bolt the shoe.

When the shoes had been bolted to the frame, the straight

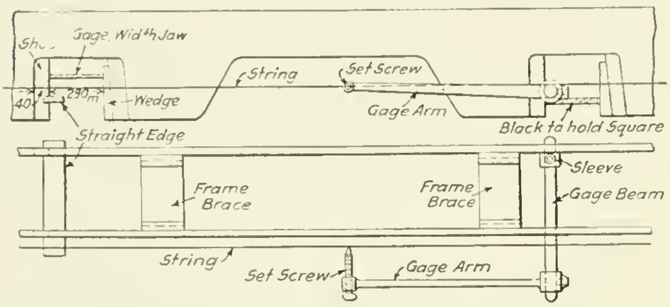


Fig. 4. Plan and Elevation of French Locomotive Frames Showing Application of Squaring Gage

edge, as shown at the left in Fig. 4, was placed so that it fitted over the shoes and checked the distance between frames. Three trams were used to obtain the correct distance between the jaws; back to intermediate; intermediate to main and main to front. With the frames carefully squared by the above method and the shoes and wedges lined there was no difficulty in wheeling the locomotives and applying the rods.

CARE AND USE OF PNEUMATIC TOOLS*

BY H. S. COVEY

There are four indispensable things required in the successful operation of the air tool, and these are dry air, volume, uniform pressure and lubrication. Dry air may be had by piping the receiving tank in the following manner: The tank should be large, set in a vertical position and provided with a draincock at the outside near the bottom. The large shop pipe should enter the tank from the outside at a point 12 in. from the bottom. When the air reaches the tank from the compressor it is exceedingly hot and has a pressure of seven to eight atmospheres; being hot, it immediately rises to the top of the tank, as does each succeeding pulsation. The air being tapped in the tank, it must remain there until sufficiently cooled. As condensation starts at once, the water falls to the bottom of the tank. As the air cools and drains, it moves downward until it finally reaches the mouth of the shop pipe and moves on its journey to the air tool in good working condition.

Volume and Pressure.—To maintain adequate volume and uniform pressure, the shop mains should be large, as they are the trunk lines which carry the air to the most distant point of the system; they should have a gradual rise until when they reach the most distant point they are considerably higher than the receiving tank. All branch lines which cross the path of the main trunk line, from which they draw their supply, should always pass above and take their air from the top of the main pipe. If there is any water still in the mains, it is at the bottom working its way back to the supply tank.

Compressed air is saturated with oil from the compressor and is never quite eliminated at the receiving tank where the first cooling of the air takes place, as previously mentioned. A considerable proportion of the oil, therefore, passes on through the shop mains and branches to the drop pipes, at which point the hose line is attached, leading directly to the air tool.

The oil has a detrimental effect on the rubber innner tube of the hose, causing it to disintegrate, particles of which become detached and enter the air tool, where they lodge in the valves and air ports of the hammer, causing serious trouble and inefficiency.

Oil and Water Separator.—Inventive minds working on this problem have recently discovered a simple device which we believe to be a solution of the trouble. This is an oil and water separator that may be made in your own shop at a nominal cost. It consists of a 3-ft. section of 5-in. iron pipe, capped at top and bottom, and is attached to the branch air pipe lines which feed the drop pipes and hose lines. The branch pipe enters the separator at the top through one side of the cap and runs down the inner side of the separator to a point three inches from the bottom when the air is liberated, escaping into the cylinder and returning to the top of the cylinder through a series of baffle plates which are attached at regular intervals to the branch pipe; this filters the air and the oil clings to the baffle plates.

The air leaves the separator at the top, entering the branch outlet pipe attached to the cap at the opposite side to the inlet. The air is thus freed from oil and such water as may still remain in the system.

The separator is drained of its accumulated water and oil through the drain cock provided at the bottom cap of the separator. Occasionally the lower cap of the separator should be removed and the baffle plates cleaned by means of a stream of compressed air which quickly removes the oil adhering to them.

Fittings.—The selection of proper fittings that will offer the least resistance to the passage of the air is just as important as large pipe lines to aid in the reduction of friction in transmission of the air from the drop lines through the hose to the air tool. Air valves which have any angle turns in the air passage are objectionable, because they impede the direct travel of the air into the hose. Hose couplings, like the valve, should have an unobstructed air passage.

Lubrication.—The close fit of all working parts of the air tool necessitates frequent lubrication, particularly in the riveting and chipping hammers. The oil used should be of good quality that will not gum; heavy black machine oil should never be used, as there are numerous air ports in valve blocks and cylinders that must be kept open. The tendency of the heavy oil is to clog these ports, which impedes the proper circulation of the air and reduces the power of the tool.

If the air is charged with water it washes away all lubricant and the hammer loses its efficiency, refuses to work, and the delicate parts and polished surfaces become rusted. The hammer should have a bath every night in coal oil, which soaks up the worn-out oil of the day, and each morning should be attached to the hose and blown out thoroughly, then fresh oiled and put in service. If treated in this fashion it will perform like a new tool.

*From an address by H. S. Covey before The Railway Club of Pittsburgh. The author is secretary of the Cleveland Pneumatic Tool Co.

More Equipment Needed.—Industry continues to be hampered by inefficient transportation. This is not a condition which can be materially aided by redistribution of cars, but can be remedied only by the purchase of a large amount of new equipment and the heavy repairing of old. Although a number of railroads are now in the market for rails, cars and locomotives, the buying movement has not yet reached large proportions. Extensive purchases on the part of the roads must wait the making of adequate financial plans. Some needs, however, such as the requirements of the repair shops, are so urgent that buying of this kind cannot long be postponed.—*National Bank of Commerce in New York.*

How Enloe Straightened Out Westdale*

The S. M. P. Thought Berry Was "Falling Down." A Visit to the Terminal Showed Why Engines Were Delayed

BY FRANK EDWARDS

THINGS were not going well at the Westdale roundhouse and hadn't been for more than a year. Westdale was the most important terminal on the Valley Division of the Central and was hard to handle even under ordinary conditions. With the unusually heavy business, which had kept up the entire year following the war, had come a dearth of competent mechanics. The combination had changed the division's standing from one of the best on the system to one of the worst. If a day went by without an

Enloe Delighted in Recounting Some of the Rush Jobs He Did

engine failure, two would occur next day and Roundhouse Foreman Berry was in despair.

Charley Berry had been made on the division and until recently had been considered a coming mechanical department official. He was just in his prime, was well liked by all the men, and was a thorough mechanic, yet the engine failures and delays were increasing monthly. Master Mechanic Gridley and Mechanical Superintendent Enloe were beginning to doubt the wisdom of leaving him longer in charge of the Westdale roundhouse. Berry had tried many times to make them see that he was handling the work to the best advantage and that all his trouble was due to the large increase in business with an actual decrease in the force, and this force only turning out about half the work it did before the war.

Enloe had made his reputation as foreman at Westdale and ever delighted in recounting to Gridley and Berry some of the rush jobs he did when he was running Westdale. Gridley had first made good on about the same kind of a job on another division and both were inclined to feel that what they could do in the good old days Berry could do now if he would just organize his force right, although neither of them could pick any definite flaws in Berry's methods.

As Enloe was leaving his office on day to go to lunch he met the general manager, who promptly said, "Enloe, I just came in on number eight. We had a 30 minute delay at Westdale on account of the engine being late and then lost 40 minutes from there in with the regular train. They tried three engines before they got one ready and it wouldn't steam. What is wrong over there, anyway?"

Enloe replied, "Things haven't been going right over there for some time. I have about decided that Berry isn't heavy enough for the job."

"How is he fixed for men?" asked the general manager.

"Why, he has more men than I ever had," replied Enloe. "Business is some heavier but I consider that he is well fixed for men. He doesn't seem to be able to handle them right. I'll investigate this delay to number eight and let you know what I find. I've about made up my mind to go over there and stay till I get that place straightened out if it takes a month."

"That might be a good idea," said the general manager, "for we are having nearly every meat train delayed there for power and then when they do furnish an engine it is usually late and frequently loses time over the division."

Other matters were then discussed but for the remainder of the day Enloe was not able to get his mind off conditions at Westdale and the delay to number eight. He knew that Gridley did not have time to make a long stay over there yet he was convinced that either himself or Gridley would

"Hansen, What Took You So Long On That Rod Brass"

have to go and stay for a while in order to get Berry lined up.

Next morning when Enloe reached his office he found Gridley waiting for him.

"I have just received a wire from Berry," said Gridley, "he fell off of number ten's engine last night and broke his right arm. The doctor is sending him to the hospital this morning and claims he will be gone three or four weeks at least. I'll go over on number nine this morning and get someone broken in on the job."

"Who have you got over there to handle the work when Berry is off?" asked Enloe.

"Well, we haven't anyone just now," replied Gridley.

*Entered in the *Railway Mechanical Engineer's* Prize Story Contest.

"You know Berry wanted our permission to break someone in on his job last time we were over there but we decided it wasn't necessary and we didn't want him to take a man out of the gang just then. Lane and Smith both used to be able to handle that place in emergency but they went to the navy yard and never returned. This is going to delay all the work we had planned on this end for a week or two unless you can arrange to oversee it yourself. I'll probably be over there a week or more."

"Now, say," interrupted Enloe, "I just promised the general manager the other day that you would start that work on this end today and that you would personally see it through. I've got things in the office in pretty good shape and I'll go over to Westdale myself and run that place until Berry gets back or at least stay till I get someone lined up that can handle it. I handled it once and I have been wanting a chance to straighten it out again. I know most of the boys down there. A few of them were working when I was running the place and I'll pick out one of them and stay with him until he gets started."

As soon as number nine reached Westdale Enloe hurried to the roundhouse and to his surprise found a young man named Scott in charge. On questioning Scott he learned that Berry, against instructions, had had the foresight to break a man in to protect his place. He soon decided that Scott appeared to be entirely competent.

The first day passed without any bad luck and Enloe spent most of his time looking over the engines in the house and in conversation with some of the oldtimers or consulting with Scott.

When Enloe reached the roundhouse next morning Scott hurried to explain that the 503 had just come in off the Baileyville branch with a front end brass that had to be reduced. "It is nine o'clock now and we just got her in the house," said Scott. "She is due to go back at ten and the chief just told me he wouldn't stand for any setback this morning as they had some stock to pick up going back. We haven't got another engine here we can use."

"We can make that all right, Scott," returned Enloe. "Let Hansen have the job. He has reduced a brass like that for me in 45 minutes many a time. I saw him working on the 816 down there. I'll see him at once and explain what we want."

Enloe found Hansen and said to him, "Hansen, the 503 is just in with a front end brass cut out. I wish you would start on it right away and do your best on it. We want to run her at ten o'clock. You have done the same kind of a job for me many a time in 45 minutes."

"I'll do all I can, Mr. Enloe," replied Hansen.

Enloe felt so sure that Hansen would finish the job on time that he dismissed it from his mind and went over to the car department and watched the work for a while. He returned about 11 o'clock and Scott explained that he had had a 30 minute delay on the 503 due to Hansen not finishing the rod brass in time. When he finished Enloe exclaimed, "Hansen has got to explain to me what took so long on that job. There is no excuse for it."

Enloe at once found Hansen and began, "Hansen, what took you so long on that brass? I've seen the day when you could have done that job in 30 minutes."

"Mr. Enloe," replied Hansen, "I am just as fast as I ever was but we don't work like we used to work. When you were here, I would have taken that brass down, reduced it with a hammer and chisel and file, hurried over to the shop and cut a liner myself and as you say I would have been done in about 30 minutes. Nowadays I can't reduce a brass myself for you have agreed with the shop committee that it is a machine job so I had to take it to the machine shop and wait for it to be done on the lathe. He had a rush job in the chuck and that delayed me 25 minutes. Then I had to hunt up a boiler-maker to get a liner cut as your agreement with the boilermakers won't permit me to cut a liner. It took me ten minutes to find him and get the liner cut. I hope that makes it plain to you why I did not finish the job as soon as you expected."

"It does," said Enloe as he walked away.

This incident gave Enloe enough to think about for the rest of the day, and he began partially to understand why Berry was not able to turn out the work as he used to. In the afternoon when Scott found a moment's leisure he said to Enloe, "Mr. Enloe the 822 will be in on number seven tomorrow morning and we have got to change her tires. She lays here 20 hours and I'll try to change them during her layover as we haven't got an extra engine just now. She is due to go back on number eight at five o'clock next morning but if we don't finish her we can double number eleven's engine back."

"There is no reason why you can't get the tires changed and get her out in her turn," replied Enloe. "I have seen

He Found Carlson and His Helper Sitting On Their Tool Boxes

Carlson change tires on that class engine more than once and have her ready to go in 12 hours. Better put him on the job and let him stay till he finishes it."

"I'll arrange to do that," said Scott.

Enloe was on hand early next morning determined to see that there was no delay in starting on the tires. He made it plain to the hostlers that he wanted the 822 hurried in the house but it was after ten o'clock before they could get the big Pacific type engine across the pit and in the house. Enloe and Scott both explained to Carlson that they expected him to change the tires on her and get her ready for number eight in the morning.

Carlson merely said, "I'll do all I can."

When Enloe started for lunch just before noon Carlson had all the rods off and was ready to jack her up. When he returned about one o'clock he found Carlson and his helper sitting on their tool box watching four laborers jacking up the engine. These men were working half-heartedly and it took but a glance to see that they were inexperienced, thoughtless and making about one fourth the progress that two good energetic men could make. On seeing Enloe Carlson got up and remarked:

"We are all ready to go, Mr. Enloe, as soon as the boys get her jacked up. I've got everything ready."

"Those fellows aren't making any headway," replied Enloe. "Why aren't you and your helper working with them? I've seen you and one helper jack up an engine like that in half the time they are doing it."

"We can't do it, Mr. Enloe," returned Carlson. "You see our shop agreement says that the mechanics and helpers will be relieved of all heavy jacking when there is a labor gang working. Scott can't spare any more of them just now."

Enloe saw green for a moment, then turned and walked away thinking of the many times he had seen Carlson in action on just such a job and how impatient the same man used to become when someone did not appear to be working fast enough and how he seemed to brush every obstacle aside in his efforts to get a job done on time.

At four o'clock, which was the quitting time for the day shift, Carlson had one tire off and was heating another. Enloe had expected him to have all six tires off by four.

Scott was well aware that Enloe was not satisfied with the time Carlson was making on the tires and for that reason hesitated about explaining that owing to the agreement he could not hold Carlson overtime on the job. Finally just at four o'clock he found Enloe and explained the situation to him.

"Mr. Enloe, we can't work Carlson overtime on that job as he has already had more than his share this week and the committee has notified me that it is James' time to work. I tried to explain to them that Carlson was the best man on tires and that we just had to have the engine for number eight but they took the position that it wasn't the machinist's fault and the company didn't have another engine here to protect their train and that the agreement was made to live up to."

"What kind of a man is James?" inquired Enloe. "I don't know him."

"He is all right," replied Scott, "on some kinds of work and can set tires but he won't make half the time that Carlson would make but we will have to use him or let the job wait.

"Go ahead and use him," said Enloe. "I can see now that you won't get her finished in time for number eight but you can double number eleven's engine back as you suggested. I believe I'll go on down to the hotel. You seem to be doing all I could expect of you, on this job, and I'll go in on number eight in the morning."

Enloe sat late in his room that night. He was thinking of the many new problems that confronted the present day roundhouse foreman and at last he could understand why hardworking Berry—hardworking with head as well as muscle—was unable to get the work done that he himself used to get done with the same size gang. He thought of the many times Berry had tried to explain all this to him and how he had refused to believe. He also came to understand why the engines' failures on his district were more numerous than on any other district of the system and that his success in holding his payroll down had cost him the high standing of his district. It was plain to him at last that labor conditions had changed greatly since he was a roundhouse foreman.

Next morning the engine for number eight was 35 minutes late. James didn't get the tires finished in time and number eleven's engine reached Westdale with a broken spring hanger. The night foreman had no other engine so had to make repairs and this caused the delay. As usual, Scott sent a statement to Enloe and Gridley explaining the delay and in this case Enloe did not close it out by saying the delay was evidently due to the poor judgment of the foreman.

It will probably never be known just what explanation Enloe made to the general manager but before Berry returned from the hospital the force at Westdale and also at the other roundhouses on Enloe's district had been increased 25 per cent. Three months later the Valley Division had again become the best division on the road, all due to Enloe lining up Westdale.

INFLAMMABLE AND EXPLOSIVE LIQUIDS IN SHOPS*

Railroad shops, especially large ones, are usually closely grouped for economy in operation, and often the congestion is such, that it renders a large proportion of the property subject to loss from one fire. Many shop properties have been added to from time to time, without much thought as to segregation of hazardous processes. This risk is increased by the fact that locomotives move in and about the shops, thus making a spark hazard. Extreme care should be applied to safeguarding the hazards, especially in the use of inflammable or explosive materials; otherwise quick spread of fire and heavy losses are not improbable.

The inflammable liquids used in railroad shops are gasoline, benzine, paint and varnish, oils, wood alcohol, paint and varnish remover and lacquers.

Gasoline

Where the main stock of gasoline or benzine exceeds 50 gal., it should be stored in underground metal tanks installed in accordance with approved regulations. Where the main supply does not exceed 50 gal., a steel drum of 50-gal. capacity with a metal faucet is a satisfactory storage container. This drum can be kept in a small, well detached metal enclosure that is kept locked and is conspicuously marked "Keep Lights and Fires Away." Where not over five gallons constitute the main supply, an approved safety can may be used. This can should be kept in a cool place. For transferring gasoline from the storage tank or drum to the point at which it is to be used, only approved safety cans should be used. These safety cans preferably should not exceed one gallon in capacity, and should be smaller if a smaller amount than one gallon is sufficient for a day's supply at any point.

In cleaning triple valves, some shops use gasoline while others use kerosene with apparently satisfactory results. Where gasoline is used it should preferably be placed in substantially constructed galvanized iron cans of as small size as practicable for the purpose. These cans should be mounted on the work tables, so that their tops are almost flush with the surface of the table, and should have a drain valve at the lowest point of the bottom. Cans should be provided with hinged covers which normally will be shut to prevent evaporation of the gasoline. Gasoline remaining in these cans should be removed through the draining valve at the close of each day. This cleaning work should be conducted at a point remote from open fires, lights or flame, and only approved electric light fixtures should be permitted.

In cleaning electric generator and motor parts with gasoline, similar precautions should be taken as in cleaning triple valves, except that more gasoline and larger cans must be used in the latter process owing to the size of the parts handled. The form of can should be of such proportions as not to be upset easily, as they are usually handled on the floor. They should be provided with hinged covers and with substantial handles, and the liquid contents should be removed from the cans and stored outside the building at the close of each working day.

Gasoline is sometimes required for removing grease and oil from upholstery and furniture. The gasoline for this purpose should not be kept in or around the shops in glass bottles or in open cans or buckets; but in a small standard safety can. When using gasoline for dry cleaning, it is recommended that the material to be cleaned be taken out doors when practicable. In cleaning cloth surfaces with gasoline, the mere friction of the cloth saturated with gasoline upon another surface is sometimes sufficient to produce

*From the report of a committee presented at the sixth annual meeting of the Railway Fire Prevention Association, held at Chicago, November 18-20, 1919.

static electric sparks, which may ignite the vapor. Fires sometimes thus occur in dry cleaning processes, in spite of every precaution in avoiding the proximity of open lights or fires.

Gasoline is used in small blow torches or plumbers torches for soldering in electrical repair shops and also for burning off paint. In some shops kerosene is used for the same purpose and naturally involves a much less fire hazard. Where gasoline torches are used they should be kept in a fire proof cabinet, preferably located outside, when not in use. They should be filled from a standard safety can, and this filling preferably should be done out of doors. The torches should be inspected frequently to insure that they are in good mechanical condition. Fires are frequently caused by workmen going away and leaving burning gasoline torches. The torch may be upset or moved so that the flame comes in contact with some combustible material.

It is of course important in using gasoline or kerosene torches for burning off paint, that they are not used at any place where varnish removing compounds are employed. In some shops large gasoline pressure tanks are used inside main buildings, and the gas produced is used in connection with blow torches for paint removing. Such practice is very hazardous and should not be permitted. These tanks should be in an underground pit, well detached from buildings, and an approved system of piping and connections should be provided.

Where tire removing is done with the use of gasoline fuel, the process should be conducted out of doors, and at a safe distance from buildings. Fuel oil and kerosene are both successfully used for this purpose at some points, and are safer than gasolines.

Paints and Varnishes

Paints and varnishes used in railroad shops are not generally highly inflammable, but are combustible, and are usually kept in quantity. They should be stored if practicable in a separate building of fire resistive construction, located a sufficient distance from other shop buildings to eliminate the danger of exposure. Paints and varnishes should be stored in sheet iron drums provided with valves for drawing off the liquid. Metal pans or troughs should be placed under the valves to catch any drips. Standard metal waste cans with self closing lids, should be provided for the reception of waste, or cloth contaminated with paint, oil or varnish. This material should be removed from the cans at the close of each day, and burned or otherwise safely disposed of.

In case any paint, oil or varnish is spilled, it should not be absorbed by sawdust, or similar material; sand should be used for this purpose.

The paint storehouse preferably should be of brick, or concrete construction. It is recommended that wire glass set in metal frames be used for window openings, and approved metal covered fire doors for door openings. At the openings between various sections, small two-inch concrete sills should be provided. The building should be heated by steam and lighted by electricity, wired in conduit, with vapor proof globes, and switches installed outside of the building.

Where practicable the oil storage should be a separate building from the paint and varnish storage. When housed in the same building a distinct sub-division should be provided between the two occupancies by a standard brick fire wall, with door openings protected by a standard fire door on each side of the opening. Oil houses should be divided into two distinct rooms; the waste room, and the main oil dispensing room. Sometimes a third room is necessary for filled barrels, where no basement is provided. The construction, lighting and heating of the oil house should be similar to that recommended for the paint and varnish storage.

The most common form of fire protection for paint, varnish and oil houses, is the steam fire extinguishing line, by which steam is introduced into the building. These lines are controlled by manually operated valves located on the outside of the building. The effectiveness of this method of fire extinguishment is dependent on the complete confinement of the steam. In order to prevent its escape, all window openings should be equipped with wired glass in metal frames, the windows to be counterbalanced to close with the melting of fusible links. If there are ventilators in the roof they should also be equipped with shutters with fusible links. Chemical fire extinguishers, and a liberal supply of sand pails should be provided. On the outside of the building a sign should be posted reading, "Keep Lights and Fires Away."

Empty and filled oil barrels or drums should be stored at as safe a distance as practicable from the oil house, and as an added precaution, protected from sparks by a noncombustible shelter. All empty barrels or drums should be tightly closed.

Paint and Varnish Remover

Paint and varnish removing compound is usually a highly inflammable liquid containing acetone, benzol, etc. It is commonly shipped to the shops in wooden barrels, which are stored outdoors until used. These barrels are not always in good condition when received, hence they should be inspected when received to see that leakage and fire risks do not occur. When paint and varnish remover are being applied to cars, these cars should be outside of and at a reasonable distance from any building. During this process no fires, lights, blow torches, etc., should be brought in the vicinity of the car.

In removing paint and varnish from small pieces, it is at times necessary to work indoors. A small detached building should be used for this purpose. This building, if not of fire resistive construction, should have all combustible parts covered with sheet iron. When dipping tanks are used for the varnish remover, these tanks should be kept covered except when objects are being placed in or removed from the tank. Not more than one barrel of the varnish remover should be kept in the building or compartment in which varnish removing work is done. Care must be taken that any liquid which has spilled or leaked is at once removed. The building should be well ventilated, and if lighted artificially, vapor proof electric lights with wiring in metal or other conduits must be used.

Metal Lacquers and Enamels

Lacquers and enamels for metals consist essentially of nitro-cellulose in amyl acetate solution, with or without other ingredients. Lacquers and enamels are commonly shipped by the manufacturers to the consumer in boxed cans of not over five gallons capacity. They are commonly kept in these shipping containers until used. Lacquers and enamels are usually applied either by dipping or spraying. When applied by dipping, the dip tanks should have approved covers, and these covers should be kept closed except when articles are being dipped or removed.

Where lacquers or enamels are applied by spraying, the work should be done where there is good ventilation. Ventilators, work tables, or other objects which are in the path of the spray, gradually acquire a coating of non-volatile residues from the lacquers. This residue consists, in large part, of dry nitro-cellulose mixed with gums, pigments, etc. This mixture is extremely inflammable, and if ignited in any quantity will make a very hot fire and one difficult to extinguish. These solid residues should not be allowed to accumulate, but should be scraped up, removed, and burned at frequent intervals. Drip boards should be of non-combustible material.

The Hump Method for Heat Treating Tools

The Critical Point of the Steel Being Treated Is Used to Determine the Proper Time for Quenching

ONE of the latest developments in heat treatment is the so-called hump method which has been developed by the Leeds & Northrup Company, Philadelphia, Pa. The method makes use of a recording pyrometer to determine when the steel being heated reaches the critical temperature, and takes its name from the fact that an offset or hump occurs in the heating curve at the transformation point. Heat treating by the hump method has been applied successfully to the treatment of gears, taps, drills, punches, dies and other types of tools.

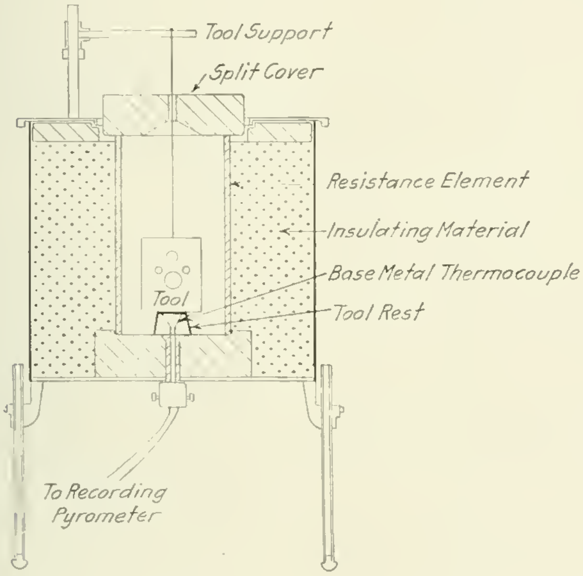


Fig. 1. Furnace Arranged for Heat Treating by the Hump Method

The usual practice when using this method is to heat the parts in an electric furnace of the type shown in Fig. 1. The tool is suspended by means of a small wire from the tool support in such a manner that it rests upon or is in close proximity to the base metal thermocouple. The top and bottom of the furnace are made sufficiently tight to prevent any amount of fresh air to enter, so that the atmosphere is practically neutral at all times. In applying the methods to production work, the parts to be treated are placed upon suitable holders, and these are placed into the furnace, so that the work surrounds the thermocouple.

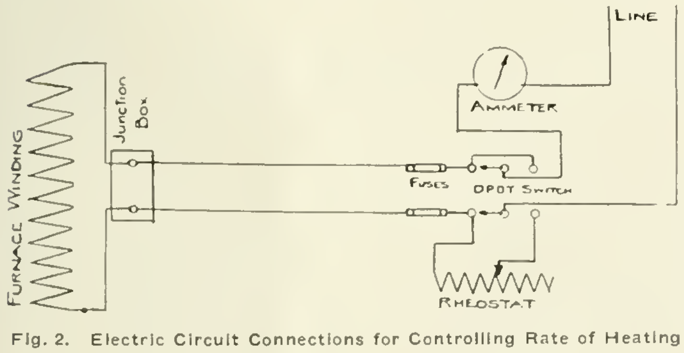


Fig. 2. Electric Circuit Connections for Controlling Rate of Heating

A rheostat is connected in series with the furnace winding, as in Fig. 2, by means of which the rate of heating of the furnace may be changed at will.

The thermocouple is connected to a curve drawing potentiometer recorder which gives a graphic record of the temperature of the hot junction of the thermocouple, but not the temperature of the work, at all times. The potentiometer recorder provides the maximum sensitiveness, and therefore enables the operator to note quickly a sudden change in the temperature of the hot junction of the thermocouple. A sample curve, showing the record of the temperature at all times while hardening a blanking die, is shown in Fig. 3.

Before the work is placed in the furnace the temperature of the latter is brought up to about 1,400 deg. F., as indicated by the thermocouple and as shown at point A on the temperature curve. The tool is then suspended in the furnace, the cover replaced and the control switch opened. Thus the energy input to the furnace ceases and the tool is allowed to slowly reach the temperature of the furnace or nearly so. In the meantime the temperature of the furnace walls will drop, as shown by the upper dotted curve. The thermocouple temperature drops rather suddenly when the cold tool is placed upon it, but soon regains some of its heat as the tool begins to rise in temperature. The rise in the temperature of the tool is shown by the lower dotted curve. When a sufficient length of time has elapsed all these bodies have reached approximately the same temperature, as shown at point B on the curve.

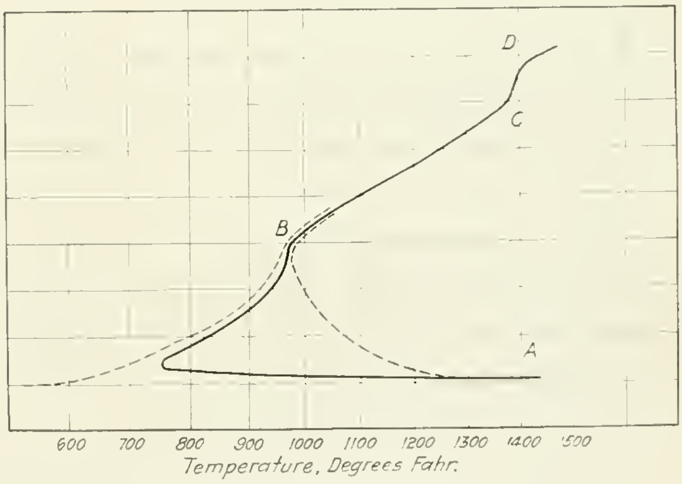


Fig. 3. Curve Showing Temperature Changes in the Furnace and in the Tool

This means that all sections of the tool are at the same temperature, or in other words, the tool has reached a uniform temperature throughout.

At this time the energy is applied to the furnace and the current adjusted by means of the rheostat to a value just great enough to increase the temperature difference within the body of the tool at any time, and when the steel reaches its decalescence point all sections of the tool will be at approximately the same temperature. When the decalescence point or critical point is reached the carbide passes into solution in the iron (see *Railway Mechanical Engineer*, April, 1920, page 236). This change causes an absorption of heat without a change in the temperature of the steel.

Consequently the increase in temperature of the thermo-

couple is affected, as shown by the abrupt change in the slope of the curve at *C*. In fact, the thermocouple behaves just as if it had gone through a critical point. When the transformation is completed, there is another change in the rate of heating of the thermocouple, as indicated at *D*. The temperature of the tool is then allowed to increase for a sufficient time beyond this point to insure hardness and quenched, as shown at the point *E*. The time allowed above the "hump" depends upon the nature of the quenching medium as well as the mass and shape of the tool as is the case in any method of hardening.

The "hump" on the curve is used as a reference point, and by its use a number of the variables which occur in present methods of heating are controlled.

In order to properly heat treat a punch or die it is necessary to control the following variable conditions:

1. The amount of increase in temperature of the tool above its decalescence or critical point before quenching. A variation in this quenching point will result in a tool being soft when it is removed from the quenching medium, or will result in abnormal growth of grain size, causing the tool to be weak and very poor as regards physical properties.

2. The uniform rate of heating of the tool, too fast heating resulting in breakage, deformation or in setting up stresses which will cause an early failure in service. Too slow heating has been found to cause a volume change in the steel which results in a very appreciable increase in the cost of finishing the tool.

3. The atmosphere in which the tool is heated. An oxidizing atmosphere results in a decarbonized surface which decreases the efficiency of the tool enormously.

4. The quenching conditions. These, from present knowledge, seem to be more under control than the heating conditions.

The use of the electric furnace and the hump method of heat treatment provide a means of controlling these variables and enable the operator to repeat or change the heating conditions at will. It does not depend upon the accuracy of the pyrometer but upon its ability to show the time of the transformation.

The gas furnace and present "soaking" method of heat treatment do not allow a control of the quenching temperature because they depend upon the accuracy of the pyrometer, upon the operator's eye to judge the difference in temperature of the thermocouple and work, and also upon the assumption that the critical point of the steel in the furnace is the same temperature as the critical point of the sample, from which determinations were made in the beginning.

The use of the lead pot or salt bath eliminates to a certain extent the error caused by the difference between the temperatures of the work and furnace, but has the disadvantage over the gas furnace of too rapid heating with practically no control of the rate of heating.

The atmosphere is hard to control in the gas or oil furnace, and while decarbonization is not serious by the use of the lead pot, we are presented with the additional problem of keeping the tool free from lead spots by its use.

By the use of the hump method of heat treatment the steel is quenched at the proper temperature as measured from the critical point of the tool itself, and not of a sample of the steel. This makes it possible to control the grain size and physical properties and to repeat the results at any time.

The uniformity of heating and control of the rate of heating eliminates the breakage, distortion and volume change which are present where there is no control over these conditions.

Comparative tests were conducted on taps hardened in the electric furnace by the hump method. Because of the fact that there was very little volume change, and therefore very little lapping necessary on the taps, the hard outer surface of the tool was left intact, and in every case the electric furnace treated tools have shown a gain of from 25 to 50 per cent. In every case except one the gain was obtained before the first regrinding, showing the maximum work obtained from those taps was before the outer hard surface was removed.

There is no inherent reason why this method cannot be applied with gas furnaces, but up to the present time it has not been found possible to control the gas to secure a uniform rate of heating. A change in the quality of the gas or the pressure will cause a hump on the curve, which will not be the critical point of the steel.

It is necessary to have all tools in one heat of the same steel or of steels having the same critical temperature. The weight of steel in the charge must also be sufficient to insure a decided hump. A relatively small charge is sufficient, however. The curve shown in Fig. 3 was taken from a furnace 8½ in. in diameter by 14 in. deep when heating a carbon steel die weighing about two pounds.

The use of the hump method of heat treatment by no means eliminates all of the problems in hardening, but it makes it possible for the hardener to reproduce or change his hardening conditions at will and enables him to gain much valuable experience and knowledge that is now lost simply because conditions cannot be controlled or repeated.

The Careless Machinist's Creed and His Reasons

1st. I believe in using a monkey wrench in preference to a hammer, because a monkey wrench looks better when it is all battered up, and besides that is what it was made for.

2nd. I believe in borrowing other men's tools in preference to buying some of my own. This is a good method of cutting down the high cost of living and saves me carting around a heavy tool chest in my travels.

3rd. I believe in oiling my machine once every six months at least. This is a great saving to the company, as oil costs something these days.

4th. I believe in keeping the shop tools in a heap on the floor instead of using the locker provided for this purpose. In this way they can have their cutting edges ruined far more quickly than by using them on the work.

5th. I believe wiping off chips with my fingers in preference to using a stock or brush provided by the company, because the former is a most ancient custom and takes the place of a surgical operation.

6th. I believe in keeping tools under the planing machine table and in reaching for them while the table is running. This breaks the monotony of life and gives opportunity for some clever gymnastics.

7th. I believe, when running my shaping machine, in having my slide rest projecting far enough to hit the bed on the back stroke. This is great fun and provides employment for the repair gang who might otherwise be out of a job.

8th. I believe in wearing loose or torn overalls and a long flowing necktie when running a high speed lathe or drilling machine. This is also a very ancient custom and a suitable dress for machine-shop work.

9th. I believe in mixing brass, babbitt, steel, and iron chips in the pans. This mixture always looks well and proves fascinating employment to the man who has to separate them.

10th. I believe in using a long-handled wrench in tightening a three-quarter bolt and much prefer a half-nut to a nut on the whole depth. This ruins the bolt at once instead of prolonging its life indefinitely.

11th. I believe in blaming the night man when anything is lost or goes wrong with my machine. He is not here to contradict me, so I can explain it all to the boss satisfactorily.

12th. Finally, I believe in abiding by all the rules and regulations of the company to the best of my ability when the boss is around.—*By N. O. Good in Deane News.*

A Measurement Record for Railroad Shops

Tabulation of Dimensions of Parts Eliminates Errors and Delays in Making Repairs to Locomotives

BY H. L. BURRHUS

THE taking and recording of accurate measurements is essential in shop work in order to eliminate delays and errors in supplying repair parts for locomotives. In a roundhouse located at a considerable distance from the general repair shop there frequently is a long delay in getting parts because the proper dimensions are not known until the part is actually needed, and often in transmitting such information to the general shops errors are made which entail loss of time and confusion at both points. Much of this trouble can be avoided by utilizing information that is available in every shop.

A system of charts on which measurements of parts may be recorded will facilitate the handling of such work, particularly at outlying points having meagre shop facilities. This system may be called a "calibration system," although not strictly within the ordinary meaning of the term. Such a system is described in this article and typical charts are shown in the drawings.

When general repairs have been completed in the back shop it has been customary to destroy the record of measurements which were secured to make repairs to the various parts. For instance, driving box lateral was figured out on a slip of paper and handed to the driving box foreman. After the engine was wheeled, lateral checked and found to be correct there was no further use for that particular record, and it was thrown away so that it would not be mistaken for that of some other locomotive.

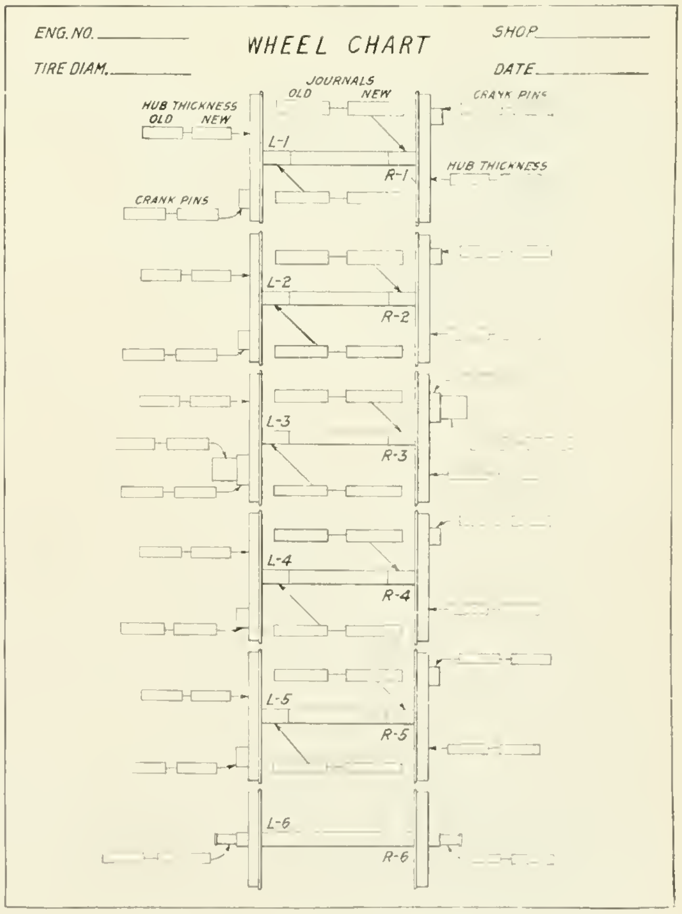
The mechanic who bores driving boxes will caliper the journals, list the sizes on a slip of paper and bore the set of boxes. As soon as the boxes are applied and found to be correct, this mechanic will destroy his record of sizes to avoid any confusion.

Cylinders are calipered for piston heads, and after the heads are applied, the measurements are soon forgotten. The shoe and wedge mechanic will caliper a set of driving boxes to secure sizes for laying out a set of shoes and wedges. After the engine is trammed he will destroy the list of box sizes. Months after the engine has left the shop and is working at a distant terminal, some piece is broken or worn out and a replacement is required on short notice, but, because no authentic record of sizes is available, long delay ensues.

Any one who has been responsible for roundhouse operation realizes the serious delay and errors encountered in trying to transmit by telegraph sizes to cover a needed part. All too frequently in the haste to send a message, some important dimension is overlooked and the back shop is forced to ship out a piece which is only partly machined, depending on the inadequate terminal facilities to finish it ready for application. If the correct information had been received, the back shop could have machined the part ready for immediate application with only a few minutes extra time, but to do the work at the roundhouse may take hours. The roundhouse foreman will often claim that the back shop pays no attention to his requests; on the other hand, the back shop forces will criticise the roundhouse man for not sending complete information. No matter which one is at fault, repairs are held up and congestion soon adds to the already numerous duties of the foreman at the roundhouse. A system of recording important dimensions would prevent this confusion and eliminate any chance of error.

If a right front driving box is required, the general repair shops will have a complete record of all sizes necessary to prepare an exact duplicate of the box which is to be replaced. Or if it is a piston head, information is at hand so that it will require but a short time to apply it to the engine at the outside terminal.

When driving wheels are removed for general repairs, the journals, crank pins and wheel hubs are calipered to determine if they are worn or out of round. These sizes can be recorded and sent to the office to be transcribed on the master chart and after repairs are completed the finished sizes can be added to the chart. In this way a record of both the original size and the finished size is obtained and the securing of this record has made very little additional work as the checking must be done in order to make the repairs. The data thus secured also give the dimensions required for driving boxes and rods. After the driving



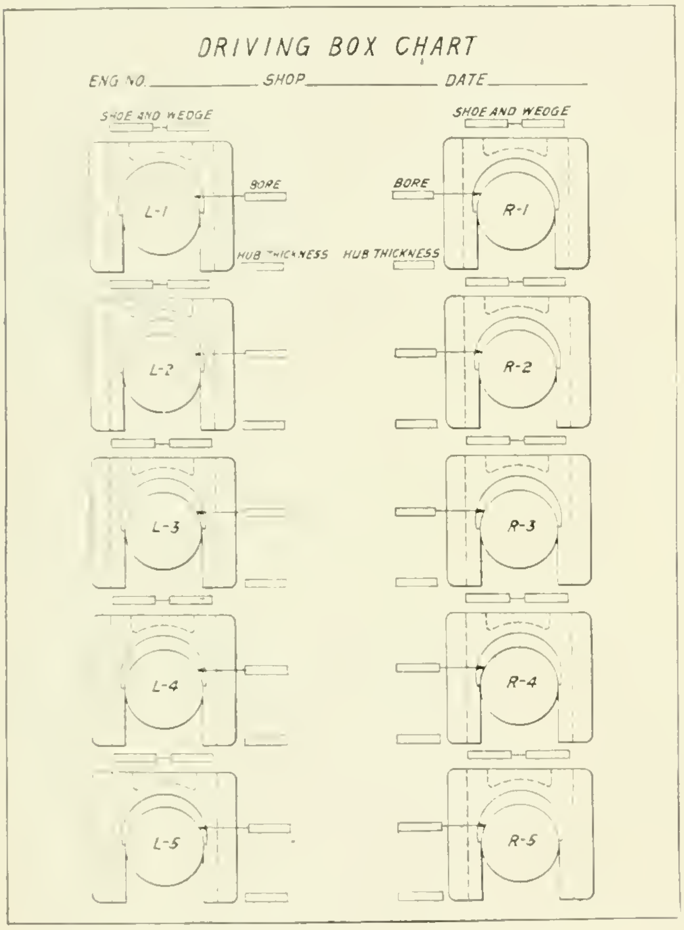
Typical Chart for Wheel Measurements

boxes are completed and the figures showing hub faces and bore are sent to the office, it is possible to record on the master chart all information pertaining to driving boxes and side rods.

Records Are Valuable In Emergency

There are some foremen who keep book records of sizes of various parts which are handled by their departments, and for many emergency jobs these records are found in-

valuable. Thus it may be said that this record or calibration system is nothing more than the gathering up and filing of valuable information that is available in every repair shop, but usually is thrown away or lost. A complete and adequate system to maintain records of essential parts can be established without adding to the duties of the supervision. Such records will not only assist in the maintenance of motive power at outside terminal points, but they will help the stores department to secure information on which to base requests for material that ordinarily requires considerable time for delivery.



Driving Box and Shoe and Wedge Chart

To simplify the recording process, charts are provided so that the terms and location of parts are identical for all shops. The information used in various departments can be assembled at the general foreman's office and tabulated on one master chart. To provide duplicate charts for the use of the shop forces, for the roundhouse or terminals, for filing in the office of the general foreman or the master mechanic and to file at the office of the mechanical superintendent, it is suggested that the charts be compiled on tracing cloth. After all measurements are filled in, blue print copies should be made and distributed.

It will be claimed that no two mechanics "feel" the same with calipers so as to record accurate dimensions. One man may caliper "heavy," while another mechanic has a "light" touch, and the difference between these two workmen's sizes will vary enough to make the record of dimensions of no value. But railway mechanics are fast coming to the use of micrometers, and micrometer measurements do not vary.

Railway work being repair work, it is practically impossible to use snap gages, but the micrometer will meet all requirements. While it is practically impossible to obtain accurate measurements with a caliper the micrometer is so finely graduated that pressure fits can be made with a fair degree of accuracy.

How the Charts Will Help

The use of these charts will enable the stores department to order material in advance, thus avoiding delays from that cause. A note forwarded to the stores department to the

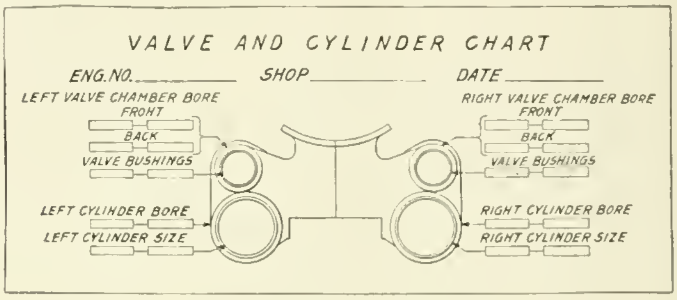


Diagram of Cylinder and Valve Dimensions

effect that certain parts had worn to the limit at the time of the last shopping gives ample time to secure new parts.

Let us analyze what this chart means to the outside terminal. A switch engine breaks a driving box. Under ordinary conditions a new box cannot be ordered until the old box is removed, so that necessary measurements can be secured. This causes delay and congestion in the roundhouse. With the calibration system in use a new box can be ordered before the engine reaches the roundhouse, and by the time it is stripped the chances are that the new box will be in the shop ready for application.

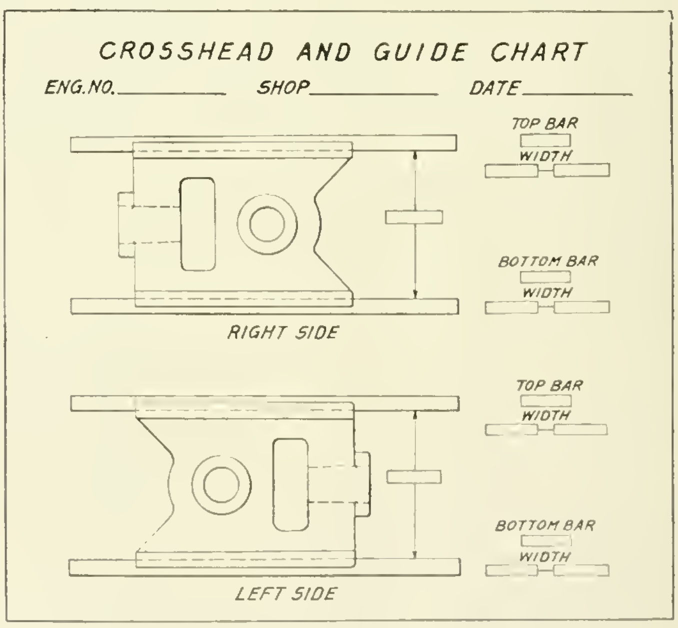


Chart for Crosshead and Guide Sizes

Analyzing the classes of repairs which confront the outside terminal and cause the greatest amount of congestion, it will be found that they can be properly placed under five general heads as follows: (1) Pistons and valves; (2) crossheads; (3) driving boxes and wheels; (4) rods; (5) eccentrics and straps.

If every outside terminal carried a stock of material to protect these five classes of repairs, each point would have a storeroom of considerable size. As it is the general practice to carry only sufficient supplies for emergency work at outside terminals the back shop or home terminal is depended on for other requirements. Thus cylinder and valve chamber

packing is one item which usually calls for rush shipments. While it is admitted that the actual sizes of the cylinder or valve chamber should be given, it is possible to prevent the tying up of power by using rings that are the same size as those used when the engine was turned out of the shop. If, however, the chart shows the cylinder size to be 22¾ in., though the original size was 22½ in., it is evident that the cylinder has been bored and that the standard rings will not answer. If rings for a 22¾-in. cylinder are furnished and at the time of application the cylinder is found to be 22⅞ in., the master chart at the home terminal should be corrected to show this dimension.

The main dimensions for a crosshead will be the sizes of the guide bearings. But when one remembers that a crosshead will be shipped which needs attention only to the wrist pin and piston rod fits, the value of having proper guide sizes can be appreciated.

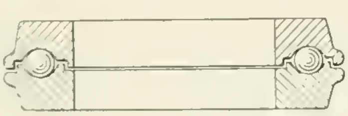
To reduce the number of charts required, driving box information can be secured from a study of the wheel chart. As side and main rods have already been standardized to a considerable extent, blue prints can be used for this item. Thus to protect these five general items of heavy roundhouse repairs, but three charts are needed. The necessary information to give correct measurements has already been secured by the back shop forces and the outside terminal receives incalculable benefit by utilizing information that the back shop usually considers of no value, and for years has thrown away. Thus a calibrating system can be organized and put into use by compiling data that is available at every repair shop.

A BALL BEARING TURNTABLE

BY G. H. BAILEY

A ball-bearing turntable, made of two old locomotive driving wheel tires for a 72-in. wheel center, is shown in the illustration. The advantages of this turntable are simplicity, low cost of construction and durability. When once installed the expense and trouble are over, as the life of a ball bearing, if it is kept well oiled, is practically unlimited.

Two old tires of 72-in. wheel center can be found about the scrap dock of almost any railroad shop and can be utilized to make this turntable without much difficulty. A 3-in. ball would be best for the bearings if the tire is not too thin



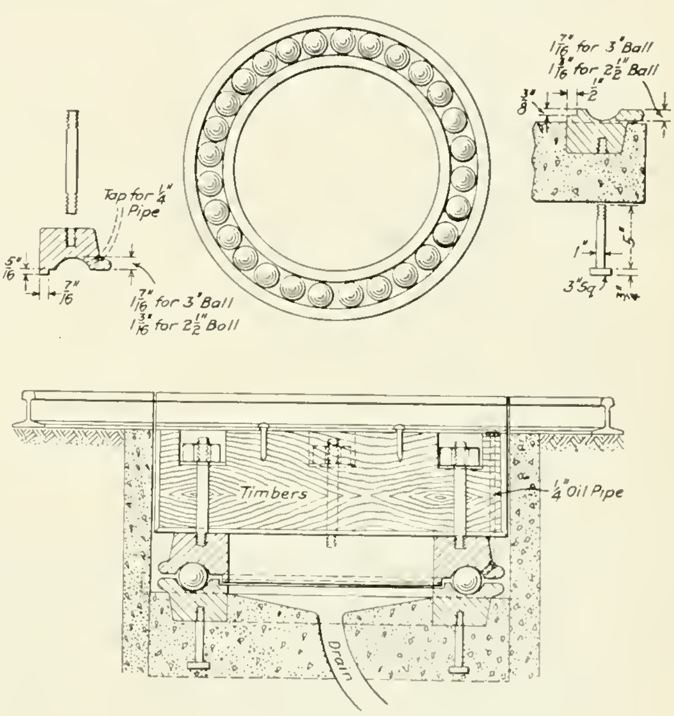
The Tires Turned With a Dust Cover

and has at least a 5-in. face to work from, as balls of this diameter are being used by many railroads for swinging rotary cranes and rotary air hoists. A ball as small as 1½ in. may be used if the tire is not thick enough to permit making a race for the 3-in. ball, the size of the ball being dependent on the tire available.

In turning or milling out this ball race a clearance of about 1/32 in. should be allowed on each side of the ball, so that friction on the balls will not be created when the turntable is in operation. When turning out this race a light cut should also be taken across the face of the tires, so that high spots will not interfere when the tires are placed together. About ⅛-in. opening must be allowed between the tires when the balls are in the race and the tires are placed in position, as the balls will wear the tool marks down somewhat, and then the tires will still clear at least 1/16 in. The tires should come close together, so that the dirt will not collect and get into the race with the balls. An offset on the tires, as shown in the drawing, takes the thrust off the balls when a heavy weight is being placed on the table. This offset should have 1/16-in. clearance, so that the tires will come in contact when a weight is being placed on the table and prevent the crushing of the balls.

A somewhat more expensive, but much more desirable, method of turning-up the tires is also shown in the drawing. In this method the upper tire is machined to overlap and project below the lower tire. This provides a cover to protect the ball bearings from the dirt that collects around the edge of the turntable.

The lower tire is embedded in concrete with six 1-in. by 5-in. bolts having a 3-in. square head and screwed into the under side of the tire to serve as stays to hold the tire firmly. The upper tire is fitted with 1-in. studs of the proper length to suit the turntable that is to be built and as many studs as



Turntable Made from Scrap Tires

may be necessary to hold the table securely to the tire. A ¼-in. pipe should be drilled and tapped into the upper tire, with the pipe running up to the top of the table, so that the bearings can be oiled with fluid oils or with a pressure gun using hard oils or grease. A cap should be provided to fit over the top of this oil pipe to exclude dirt from the bearings. The concrete bed should be arranged to provide for connection to the drainage system.

WELDING LOCOMOTIVE FRAMES

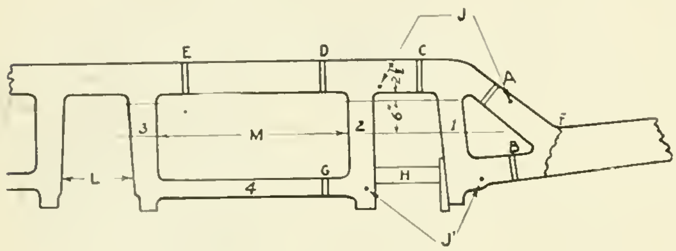
BY M. C. WHELAN

Blacksmith Foreman, St. Louis-San Francisco, Kansas City, Mo.

In thermit welding the practice of heating the lower member when the top is broken is not satisfactory, unless the lower member is kept hot until the top is cold, and in most cases by the time that the black heat contraction is taking place the lower member has been entirely cold for some time. As a result the strain on the weld is tremendous. The method described supersedes the practice of jacking up or distorting the frame to procure expansion and keeps the frame in alinement at all times. The method is not an experiment, but has been adopted and used after a thorough study of the other methods in vogue. The following instructions to be followed in connection with the sketch fully describe the procedure referred to.

When the frame is broken at *A*, the top and bottom should be trammed at *J* and *J'* and expanded by heating the pedestal

jaw at I, using bar and wedge H or jack, care being taken that the top and bottom tram marks show the same amount of expansion. After the frame at I is black hot, the bar H, or jack, may be removed, as no pressure remains. After the wax pattern and mold box are applied a fire brick furnace should be constructed so that heat will radiate around the frame jaw at the same point where the heat was applied to expand—namely, I. Two hours and a half after the crucible is tapped, and when contraction is started in the weld, I should again be heated through a hole in the furnace to a good high heat and then all holes in the furnace should be closed. The frame should then be luted with clay to retain the heat and allowed to contract to the original length while cooling at A. The following morning the frame should be heated again at I and



Welding Diagram for Locomotive Frame

at B to a low red heat. This will eliminate any strain which may remain from uneven cooling of A and I.

If this procedure is followed there will be no strain tending to break the frame at or near the part repaired. A glance at a broken frame in the box section will often show the enormous strain left in the frame by the fact that it is 1/32 in. to 3/32 in. apart at the break.

When a frame is broken at B it should be heated at the same place as if broken at A—namely, at I. It should be wedged for expansion at B, after which the furnace should be placed at I and heat applied $2\frac{1}{2}$ hours after the weld is made. Heat should again be applied at I and B as a final preventive against strain. This method may be applied at any point on the frame. If the break is at D the frame should be heated for expansion at 2 and wedged at H, using the furnace at 2, and lastly heating at 2 and 4. If at E, it should be handled in the same way by heating at 3, using the wedge H at L, and lastly at 3 and 4.

In welding a heavy frame at D and G recently a great deal of labor was required to strip for room, so that both frames could be welded at the same time in conformity with our practice. The frame was spread at M for the weld at D, after which, by heating at 2 and wedging at G, the weld was made at G by using the furnace at 2 and finally heating at 2 and 4 (3/16 in. expansion is enough for heavy frames when using this method, as there is no pressure against the frame until the jaw is hot, after which the frame contracts naturally and uniformly). This procedure will not distort the jaw.

A number of welds have been made at F under the saddle, which is a difficult place and requires at least $4\frac{1}{2}$ hours to heat properly in order to make a successful weld. Care must be taken to have the heating gate so set that the heat will strike directly on the heavier member of the broken parts. If the heavier part is hot the heat from that part will heat the lighter one. Expansion at this point is gained by placing a heavy rail across and through the jaws of both frames and a heavy jack placed between the saddle and this support.

When frames are broken at C, expansion is gained in the usual way by the use of bar H, as shown in sketch. Welds at C and F require about 3/32 in. more expansion than with the expansion system of heating, on account of the pressure on the weld when contraction is taking place after the wedge is out.

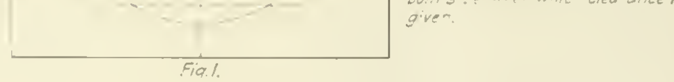
If the wax pattern and mold boxes are properly applied, the pouring gate made high enough to overcome any back pressure when the metal rises in the mold and the frame heated up to at least 1,100 deg. F. before tapping, no failures will occur where this method is followed. To obtain the temperature required for large breaks, such as 5 in. by 12 in. or over, two heating gates should be used, one on each side if possible, using a double burner preheater. On extra high welds two pouring gates or one sub-gate to assist in carrying the metal should also be used.

IMPROVED METHOD OF FITTING BRASSES

BY A. W. C.

When a main pin brass is being fitted to the pin it is a general practice to file away the portion of the brass as shown by the dimension X in Fig. 1 for the whole width of the brass, so that it will have no bearing on the pin at these points. It is obvious that if the brass is a tight fit in the rod (and it should be) there is a tendency for the ends of each half brass to close on the pin and cause it to warm up, a condition which is probably further aggravated as the brass gets hot. In the marine type or stub end rod (the name generally applied to a main rod of the type that has no strap but an open end), if the block is a trifle smaller than the brass, the closing together of the rod ends when the bolt is tightened will also cause the brass to pinch on the pin, so the advisability of filing this clearance is apparent.

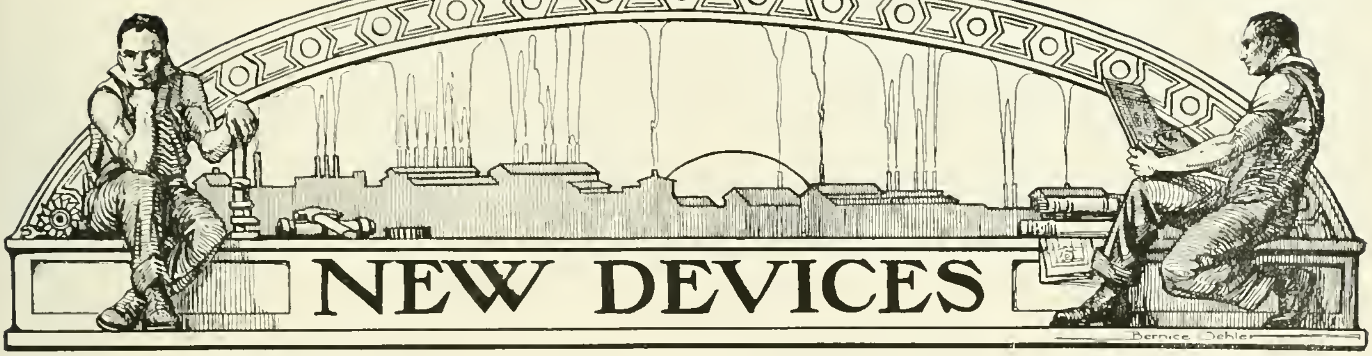
The following method of providing clearance at this part of the brass has given good results: Before the brasses are bored, galvanized iron liners about .025 in. thick, of the shape shown in Fig. 2, are placed between the half brasses, one at the top and one at the bottom. The brasses are bored out .035 in. to .040 in. larger than the pin, and it can be easily seen that when the liners are removed and the half brasses are placed together the bore of the brasses measured horizontally is from 10 to 15 thousandths larger than the pin, which is a good fit for this class of work, and when measured vertically is 35 to 40 thousandths larger than the pin, giving a very reasonable clearance at both top and bottom of brass. This method has the advantage of providing a positive, uniform clearance and eliminates all guesswork upon the part of the



Brass and Liner Used for Obtaining Clearance

workman fitting the brasses. After boring, only a small amount of scraping and spotting is necessary to complete a good fitting brass.

It is not unusual for a machinist to allow the calipers a small amount of side-play when boring a hole for a running fit to indicate that the hole is a small amount larger than the size the calipers are actually set for. If only the usual amount of side-play is given in this case, it is obvious that when the liners are removed the brass will be found bored the thickness of the liner too small, as the brasses will not butt together over the pin. If a piece of galvanized iron about 1/16 in. wide, of the same gage as the liners, is used to place one leg of the calipers on, the usual amount of side-play may be given and no difficulty in making a good fit will be experienced.



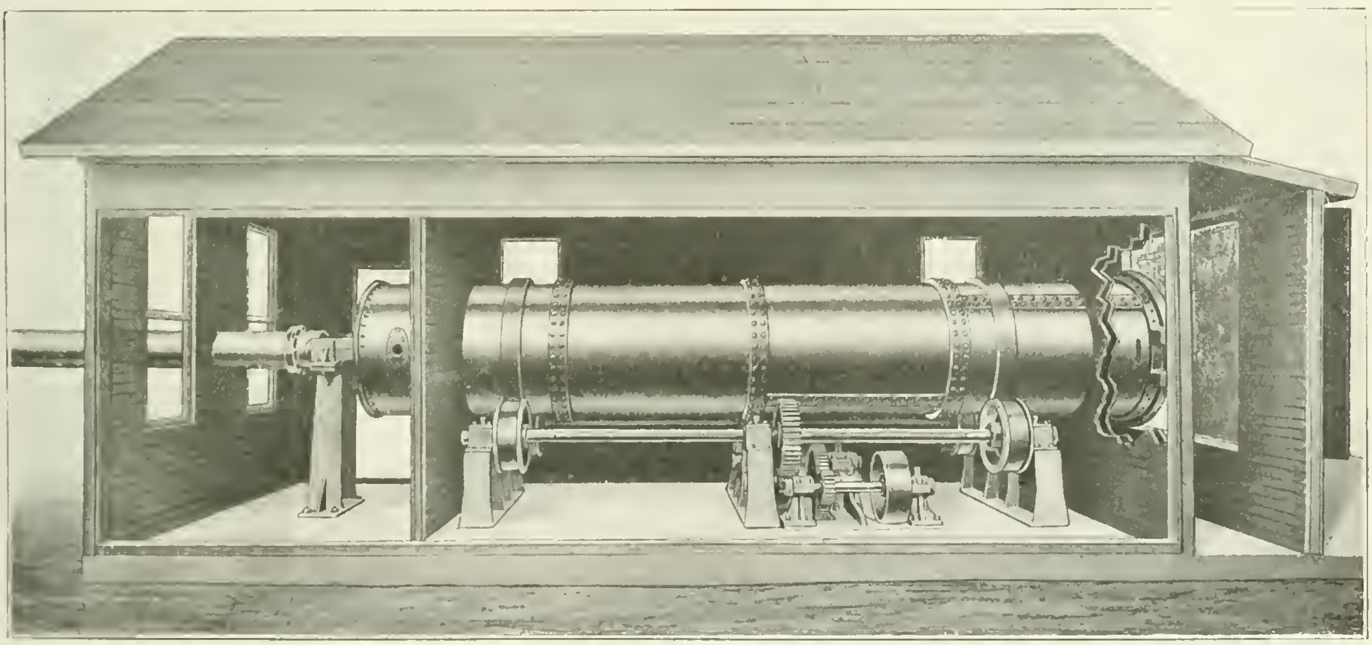
A Flue Rattler Which Cleans by Friction

A DRY flue cleaner of the revolving drum type which removes the scale by friction between the tubes instead of by impact, has been developed by the Baird Pneumatic Tool Company, Kansas City, Mo. The inside length of the rattler drum is adjustable for different lengths of tubes, so that a uniform allowance for longitudinal movement in the drum may be maintained. The cleaner is loaded through one end of the drum and the entire load of cleaned tubes is ejected in one operation.

The rattler drum has a diameter of 50 in., and is 25 ft. long inside. It has a capacity of 300 two-inch boiler tubes, 250 2¼-in. boiler tubes or 50 superheater flues. From one to six hours per load is required for thorough cleaning, the time depending on the nature and thickness of the scale.

One end of the drum is closed with double doors hinged at opposite sides, through which the tubes are placed in the drum. At the opposite end is placed a movable bulkhead, which is operated by the piston in a 14-in. air cylinder. For tubes requiring less than the full length of the drum, this bulkhead is moved in far enough so that the length of the cleaning chamber is but six inches longer than the tubes to be cleaned. The length of the air cylinder is such that, after the tubes have been cleaned, the bulkhead may be used to push the complete set ejected from the drum into a push car, or cradle, if crane service is available, thus eliminating one handling of the tubes.

The drum is driven by a 25 hp. motor operating at 900 revolutions per minute through gears which reduce the rotation of the drum to 30 revolutions per minute. The cleaning process is simple and effective. Rattlers of the usual type depend on the shock of impact of the tubes against each other to crack and remove the scale. In the Baird rattler the tubes are not subjected to impact, but are rotated one against another. The friction of this rotation generates a large amount of heat, and the rise in temperature causes the cracking and removal of the scale. As the scale is removed in this manner it is pulverized by the movement of the flues against each other, all moisture is expelled by the heat, and the pulverized scale, which ultimately assumes the fineness of flour, forms an effective scouring compound. The finely ground material has a tendency to rise in the revolving drum, from which it finds outlets through slotted openings near the ends of the drum. The portions of the drum containing these openings are enclosed in dust-tight rooms which prevent the scattering of the fine scale through the shop and keep it away from the gears and driving mechanism. Coming from the drum, the tubes are clean inside and out.



Baird Flue Cleaner

The first Baird rattler was installed in the shops of the

Atchison, Topeka & Santa Fe, at Topeka, Kans., over five years ago, and there are now ten installations in service on five railroads. At the time of the first installation, the new machine was confronted with an accumulation of some 200,000 dirty tubes, and for the first nine months after it was placed in service it operated 24 hours a day. Since that time it has been operated 16 hours a day. After a total operation of nearly 40,000 hours, the only cost of maintenance or loss of time was the result of an accident caused by the dropping of a bolt into the gears. The accumulation of tubes was cleaned up and the rattler has since kept up with the shop production. The service of this installation has also resulted in the elimination of warped and broken tubes, which are regular accompaniments of the use of rattlers of the impact type.

The total length of the Baird machine is 54 ft. 3 in., and its greatest width, at the base plates under the central portion of the drum, is 85 in. The base plate itself is 15 ft. 2¾ in. in length by 5 ft. 10 in. wide, and the center of the cylinder is 5 ft. 8 in. above the base plate. The overall height is 8 ft. 2 in. As is shown in the illustration, the 14-in. air cylinder for operating the movable bulkhead may be extended outside the building in which the rattler is located, thus materially reducing the amount of floor space required.

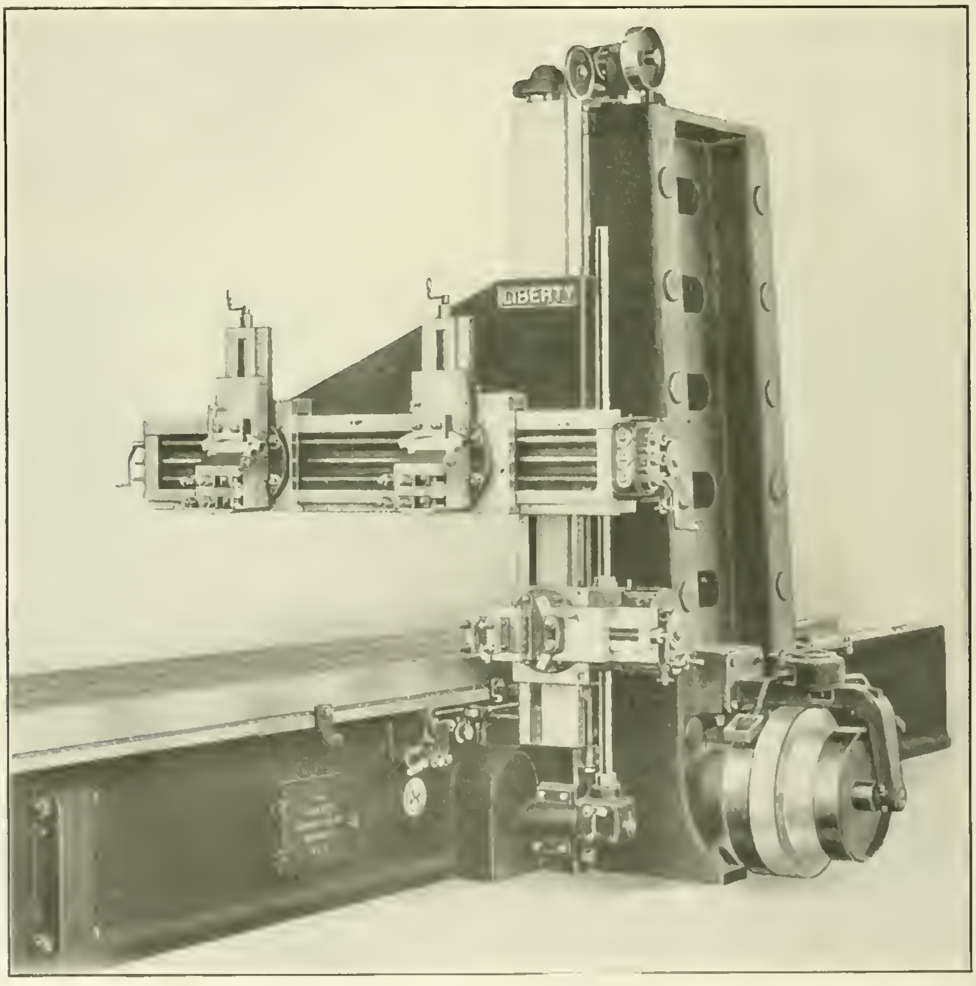
Open Side Planer for Railway Shop Use

WHILE open side planers have not been used extensively in railway shops in the past, there is no doubt but that certain planing operations can best be performed on this type of machine. For example, a deck casting 44 in. wide that had been cracked and welded, might require planing on one side. This light job could be done on a 30-in. open side planer, but would require a heavy 48-in. double housing planer to pass the casting between the housings. There is no objection to the open side planer on the ground of its lack of rigidity. Heavy cuts may be taken on an open side planer with the cutting tool and cross rail head seven feet, or even more, from the housing.

Manufactured by the Liberty Machine Tool Company, Hamilton, O., the open side planer illustrated is designed to stand the stresses peculiar to this type of machine. Due to the rigid construction of the bed, column and cross rail, it is possible to take cuts up to the capacity of modern tools. The unit system of parts makes it possible to attach any additional units after the planer is installed, and should it be desired to use the machines as a double housing, four head planer, the left-hand housing and head can be attached at any time. Ample safety appliances protect both the operator and the machine at all times.

The planer bed, extending to the floor, affords a solid foundation for the machine. The top is closed between the tracks, except through the gearing section, which is reinforced by heavy girths. The tracks are wide and V-shaped, with an ample spread to eliminate unnecessary overhang of the table. Lubrication is furnished by automatic rollers. The running gear is placed inside the bed, easily accessible from the top. All torsional strains on the shafts are relieved by pressing the gears on to the pinion hubs.

By careful design, especially of the pulleys, the shifting mechanism shifts the belts quickly and quietly and there is no accumulation of dirt on the cam and other moving parts due to the mechanism being enclosed. By means of shifting levers on both the front and rear sides of the machine, the operator can control the motion of the table without walking around the planer. A safety lock is provided to prevent accidental starting. The T-slots in the table are planed from the solid stock and reamed holes throughout the entire table length afford ample facilities for clamping. The column is of the two-faced box type construction, extending to the floor. It is bolted and doweled to the side of the bed and the wide base is arranged for bolting to the foundation.



General View of Liberty Open Side Planer

In operation, the power is transmitted from a spur gear on the end of the bull pinion shaft through a pair of reversing mitre gears to the vertical splined feed shaft. A handle conveniently located determines whether the feed is to take place on the cutting or on the return stroke. With the handle in a neutral position, all feeds are disengaged.

The amount of feed is determined by adjustable stops operated by a knob. Among the advantages of the special patented feed may be mentioned the possibility of controlling or changing the feed or rail head position at any time without stopping the machine or disturbing the feeds on other heads. Feed indicating dials enable the operator to set the feed at any required amount.

Great care was exercised to secure a rigid cross rail. It is triangular in shape, with a long and narrow guide extending upward on the front of the column. It is bolted and doweled to the triangular brace or knee which extends to the rear of the column where it is rigidly clamped by T-slot bolts in addition to a rail clamp.

Both cross rail heads are provided with long and wide bearing surfaces on the cross rail and are made right and left for close range. They are graduated for swiveling up to 90 degrees, and have automatic feeds in all directions. A great convenience to the operator results from the power elevating device located on top of the column.

The side head is mounted on the front of the column to avoid any unnecessary overhang of the tool which is brought up close to the point of support. The side head is properly counterbalanced, provided with automatic feed, and can be swiveled. The tool block is fitted with a heavy releasing spring plunger. The Liberty open side planers are made in four sizes: 30-in., 36-in., 42-in. and 48-in.

Drill Press Equipped With Electric Control

Both a.c. and d.c. electric control have been applied to the heavy duty drill presses shown in the illustrations and manufactured by the Colburn Machine Tool Company, Franklin, Pa. One drill press is equipped with a Cutler Hammer alternating current electric control and the other with a special direct control for reversing the spindle for tapping operations. Colburn drill presses have been arranged for reversing the spindle when provided with direct current motor drive for some time, but it is only recently that any equipment has been available which would reverse the spindle satisfactorily when alternating current motor drive was used.

The alternating current equipment (Fig. 1) consists of an automatic motor starter and a reverse switch. The automatic starter is contained in a metal box which may be mounted directly on the machine or fastened to the wall as illustrated. The reverse switch is mounted on the column of the machine directly above the feed gear box, and is connected to the operating lever by sprockets and chain. It has three positions; forward, neutral and reverse.

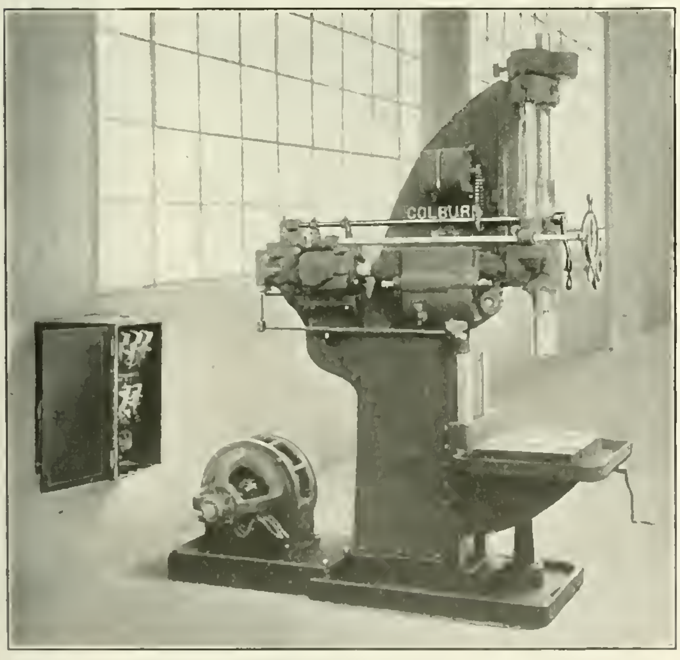


Fig. 1—Colburn Drill Press With Alternating Current Control

The operator when tapping a hole, simply throws the lever to the forward position and when the tap reaches the desired depth, throws it to the extreme opposite (reverse) position which reverses the spindle instantly and withdraws the tap. To stop the machine, the lever is thrown to the neutral position.

For direct current equipment (Fig. 2) there is an automatic motor starter and reverse switch which differs somewhat in mechanical detail from the alternating current equipment. In the illustration the starter and reverse switch are shown mounted directly on the column of the machine. This reverse switch also has three positions; forward, neutral and reverse and the control is carried to the operating lever at the front by means of a lever and link.

In operation the d.c. mechanism acts similar to the a.c.. Throwing the lever to the forward position starts the spindle. Throwing it to the extreme opposite position reverses the spindle and throwing it to neutral, stops the spindle immediately. The illustrations show reversing a.c. and d.c. motor control as applied to the larger Colburn drill presses but either style of control is readily adaptable to the smaller sizes. The advantages of the electrical control include increased life of the machine due to a reduction in shocks and jars, and a considerable saving in taps that would otherwise be broken.

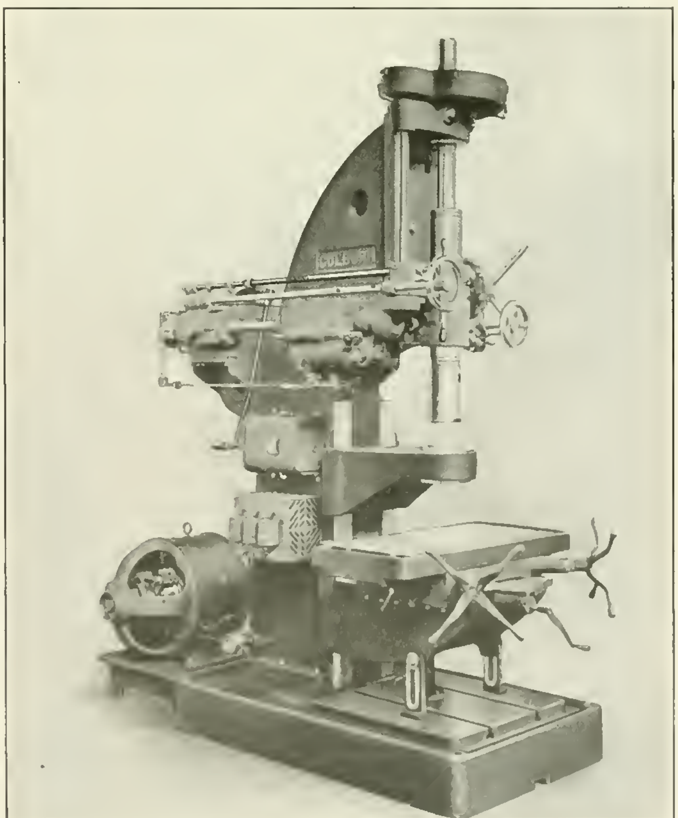
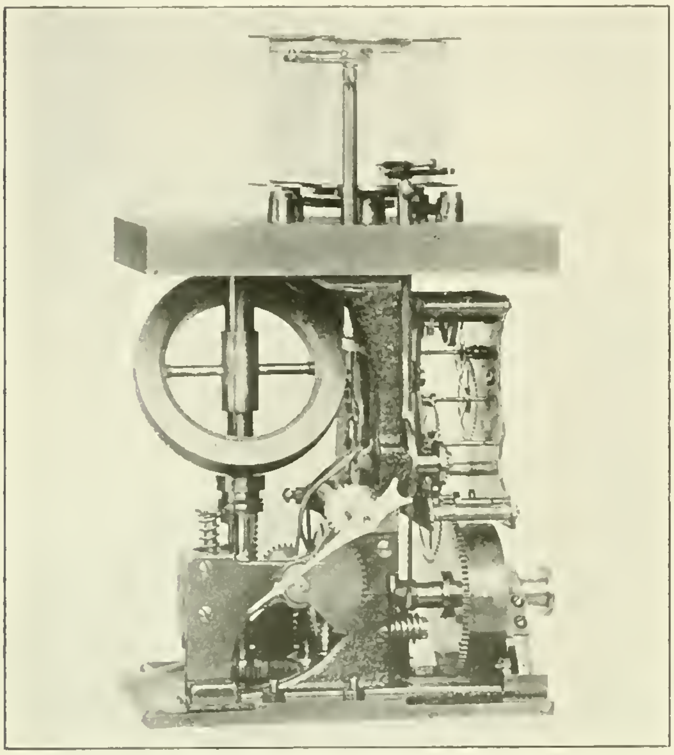


Fig. 2—Colburn Drill Press With Direct Current Control

Recording Instrument for Road Locomotives

THE model *K* Loco-Recorder is a durable American-made machine, designed to indicate a locomotive's speed at all times to the engineman and give a permanent record of that speed, also the direction of motion, whether forward or back, and the time spent at station and other stops. The instrument increases the safety of train operation by practically eliminating the danger incidental to excessive speed on curves or at other points where there are speed restrictions. By furnishing an accurate record of the speed at all points there is a



Internal Mechanism of the Speedograph Loco-Recorder

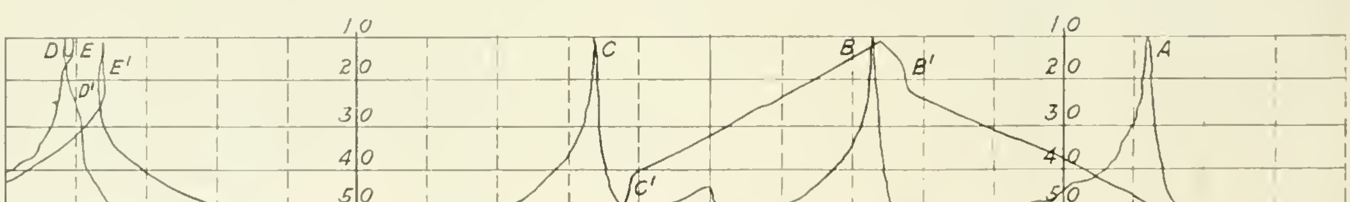
tendency to prevent unnecessary wear and tear on motive power, rolling stock and tracks through express train speeds of locomotives built for slow and heavy service. The need for such an instrument is especially urgent at the present time because of the increased costs of labor and material and the much larger and heavier locomotives and cars.

Two views of the instrument illustrates its general appearance and working mechanism, and part of a typical record made by a locomotive in regular service also is reproduced. The entire story of train operation is recorded so clearly and concisely on the strip of recording tape that it can be read at a glance. Part of the instrument is built on the plan of a speedometer, depending for its action upon centrifugal force applied to the ring shown, which actuates the indicator pointer, showing the exact speed at which it is running.

Two pencils operate independently of each other on the chart, one showing speed and the other time. The recording tape is driven by the locomotive through a connection with one of the driving wheels and moves at the rate of half an

The Recording Mechanism is Protected by the Metallic Cover Which Can Be Securely Locked

inch to the mile in keeping with the speed of the locomotive; when the locomotive stops the tape stops, and when the locomotive reverses the tape also moves backward. This makes the record easily adjustable to a keyboard, representing in the same ratio the division over which the train is operated. Stations, towers, sidings and all points at which there are speed restrictions are shown on the keyboard, together with any other desired information. By placing the record against the keyboard the speed at all points and the location and



Reproduction of Part of a Record, Covering 19 Miles, Made by a Locomotive in Regular Service

duration of all stops and slowdowns are clearly shown. The tape is calibrated horizontally in miles per hour to facilitate the reading of the speed record, and perpendicularly in miles of track, with heavy lines every five miles.

The speed pencil moves across the tape in proportion to the speed of the locomotive. It returns to zero at the top of the tape at every stop, and acceleration and deceleration are plainly shown. Its action is positive and every change of speed is instantly indicated on the dial and recorded on the tape. The pencil accurately records the speed shown to the engineer on the dial; the mechanism is so interlocked that it can record nothing else. Changes of gears to compensate for the turning down of tires are furnished with each instrument to insure precise accuracy in speed indications and records.

The time pencil is actuated by a clock and moves back and forth across the tape in 10-minute strokes; 10 minutes up and 10 minutes down. When the train is in motion this pencil makes an angular line, the angle depending on the rate of speed, and when the tape stops it makes a straight vertical line, the length of which shows the duration of the stops, on the basis of 3/16 in. to a minute. This records the length of all stops up to 20 or 30 minutes in length. The dial pointer, which indicates the speed to the engineer, is the only working part of the instrument that is exposed to observation. The cover of the case completely encloses the recording mechanism and tape and is securely locked.

The record illustrated was made by a locomotive moving from the right to the left, and *A*, *B*, *C*, *D* and *E* are stops. The line connecting these points is made by the speed pencil, and shows the speed at all points and the distance covered in bringing the train to a stop and picking up speed again.

Referring to the record, *A'*, *B'*, *C'*, *D'* and *E'* are vertical lines made by the time pencil giving the length of stops at *A*, *B*, *C*, *D* and *E*, respectively. They show stops of approximately one minute at *A*, *B* and *C*. After stopping for about two minutes at *D* the train was backed, at a maximum speed of about 13 miles an hour, an eighth of a mile to *E*, where it stopped for nearly three minutes before resuming its run. It attained a speed of 57 miles an hour in three miles after leaving *A* and immediately began to slow down for *B*. The highest speed of this train, on the section of its record shown, was 60 miles an hour before reaching *D*. Midway between *B* and *C* the speed was sharply reduced from 53 to 44 miles an hour, but was immediately increased. From the foregoing it is evident that a complete, detailed record is available of train operation over the division in question.

Red E. High Speed Lathe Center

Lathe and grinding machine centers made of carbon steel often burn at the points and freeze to the work. It has long been recognized that high speed steel centers would obviate such difficulties and allow the machine to be operated at its maximum capacity, but high speed steel is expensive. It would seem poor economy to make a lathe center entirely of high speed steel when possibly less than ½ in. of the point would be used, the rest going into the scrap bin.

Lathe Center With High Speed Steel Point

The Ready Tool Company, Bridgeport, Conn., has offered one solution of the problem by making a solid lathe center with a nickel steel body and a high speed steel point. The high speed steel extends back from the point about one-quarter the length of the lathe center. On account of its solid construction, vibration is reduced to a minimum and due to the high speed steel point, the lathe center life is increased many times.

The advantages of the Red E. lathe center include not only the possibility of machine operation at a higher speed but a considerable saving in the machinist's time previously spent in grinding centers. The center is made with Morse and Jarno standard tapers, and will fit any standard make of lathe or grinding machine.

Anti-Slip Surfacing Decreases Accidents

The hazards due to dangerous walking places are underestimated by many people, who doubtless would be surprised at the large proportion of accidents due to so apparently harmless a thing as slipping. It is difficult to get conclusive data on the subject, since casualties are often charged erroneously to other than promoting causes, yet the casualties resulting from unsafe walking are greater in number and severity than those due to any other public or industrial hazard. Based on U. S. motality statistics, the total fatalities for the continental United States were 76,500 in 1915. Of these fatalities, 14,855 were caused by falls, over half of which occurred on stairs and oor levels.

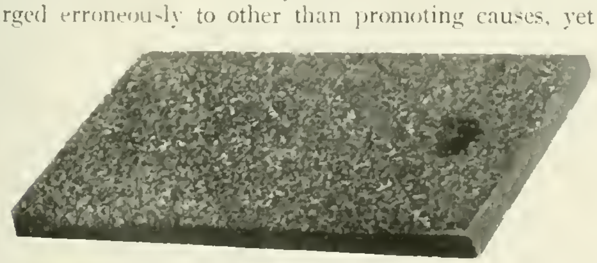


Fig. 1. View Showing the General Appearance of Vulcalum

With the above facts in mind, it is evident that too much care cannot be taken to provide safe walkways, inclines and steps in all public buildings, passenger cars and coaches. In addition, running boards and surfacing around the switch boards in power houses, where a slip may result fatally, should be surfaced with a material that will prevent slipping.

A new form of abrasive walkway surfacing called Vulcalun, has been placed on the market by the American Abrasive Metals Company, New York, and is proving satisfactory under exhaustive tests. Vulcalun is a mixture of rubber and abrasive grit vulcanized to a steel reinforcing plate contained entirely within a pure rubber base. A good idea of the general appearance of the substance is given in Fig. 1, which shows a sample piece. A cross section of the sample is shown in Fig. 2, in which *A* is the abrasive grit, *B* the perforated steel reinforcing plate and *C* the rubber base.

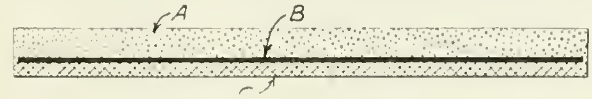


Fig. 2. Cross Section of New Abrasive Metal Surfacing

One result of the tests referred to was definite proof of the value of Vulcalun in the prevention of slipping. On a new

railway station stairway equipped with corrugated treads and subject to heavy passenger traffic, there was an average of two falls a day for a period of two months. With abrasive metal treads substituted, the succeeding two months failed to show a single fall.

Owing to the abrasive rubber surface and steel plate Vulcalun resists wear and will not crack under severe vibration. The material is adapted not only to walkways and coach steps, but due to a high dielectric strength, is desirable for surfacing around switchboards in power houses. Tests have shown that there was no electric leakage through the material up to 7,500 volts and the flashover did not occur under 20,000 volts.

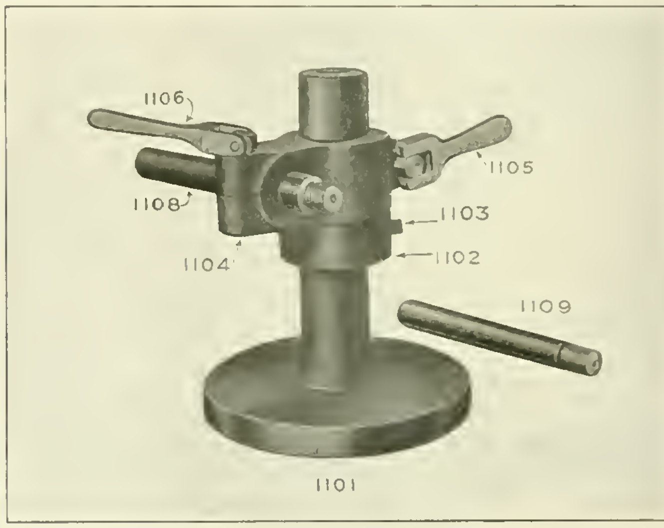
Vulcalun is light in weight, above 3½ lb. per sq. ft., and therefore is desirable for elevator car floors in freight houses and shops. Due to being enveloped entirely in a rubber base the steel reinforcing plate does not corrode; there is no tendency to disintegrate when saturated and exposed to freezing. The material is uniform in finish and manufacture, easily kept clean, and easy to renew when necessary.

Universal Vise for Pneumatic Drills

THE purpose of the repair vise illustrated is to firmly clamp and hold a pneumatic drill in various accessible positions while making necessary repairs, assembling or testing. The vise should be placed near the repairman's regular bench vise preferably on the right hand side. This arrangement leaves the regular bench vise free to be used should occasion arise. In general the drill may be clamped in any of three positions which may be most convenient for removing the gear case, spindle and valve gear; removing the valves, exhaust caps and feed screw; or for reaming piston holes or general inspection.

As shown in the illustration, the repair vise consists of a flanged upright machine post or stand *1101*, a sliding stop collar *1102* held by a suitable set screw *1103*, and a clamp *1104* which is securely held in any position on the post by tightening the quick action clamp screw *1105*. At the other end of the clamp there is a hole in which stem *1108* is engaged. This stem is threaded at one end with ½-in. and ¾-in. pipe threads respectively. For the small sized drill, a clamp with a ⅛-in. pipe thread is used in connection with a special clamp support.

Pneumatic drills are used very extensively in railway shops and the question of keeping them in repair is always a pressing one. The universal repair vise illustrated will facilitate in making quick repairs and for this reason is of interest to railway men. The vise is made by the Independent Pneumatic Tool Company, Chicago, Ill.



Thor Assembling and Repair Vise for Holding Pneumatic Drills

Car Hauling Winch Reduces Switcher Work

A NEW type of electric car hauling winch recently developed by the Shepard Electric Crane & Hoist Company, Montour, N. Y., is shown in Fig. 1. The operating units of this machine embody many of the distinctive features of the Shepard electric hoist. All moving parts are fully enclosed, making the machine entirely weatherproof with the exception of the motor. Oil bath lubrication is provided for all the gearing, brakes, etc. The gearing is of the balanced drive type, driving at two diametrically opposite points. This insures long life, high efficiency and a practically noiseless drive.

The winch is mounted on a cast base which encloses the controller resistance. A standard Shepard controller is used which may be mounted directly on the base or separately for remote control. When desired, the machine can be furnished with a gear shift, giving a reduction of four to one. This

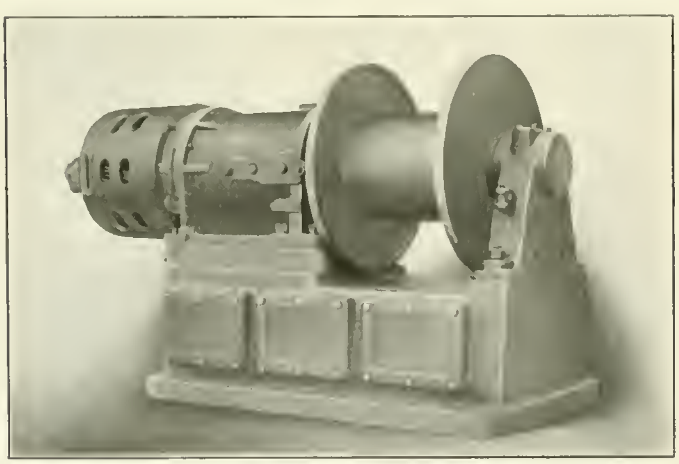


Fig. 1. Shepard Electric Car Hauling Winch

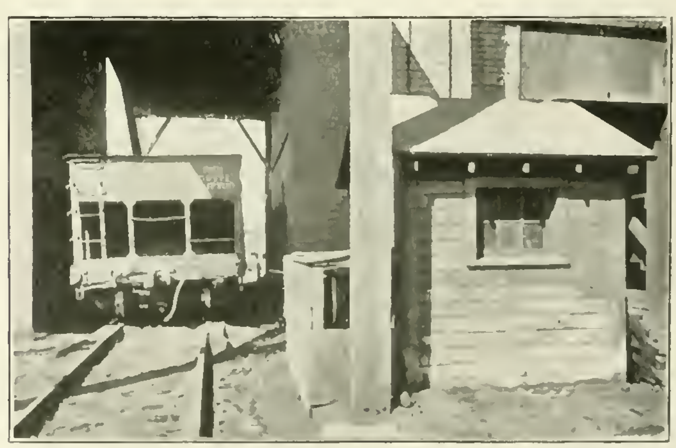


Fig. 2. Car Hauling Winch Installed at Coaling Station

enables the winch to handle four times its normal, rated load.

A recent installation of this winch in the new coaling station of the New York Central at Rensselaer is shown in Fig. 2. It is used in place of locomotives to draw loaded coal cars up to the coal dump. The winch capacity is 4½ tons at a speed of 55 ft. per min. and the winding drum has a capacity of 250 ft. of cable. Alternating current is furnished through a 22-hp., three-phase General Electric motor. Two hundred feet of ⅞-in. wire rope are used. The machine is installed in a winch house as shown with the drum extending outside.

In a test made of the Shepard car hauling winch recently, 14 coal cars were pulled around a curve and up a grade after being partly frozen in. The winch is reported to have withstood all tests of winter weather with gratifying results.

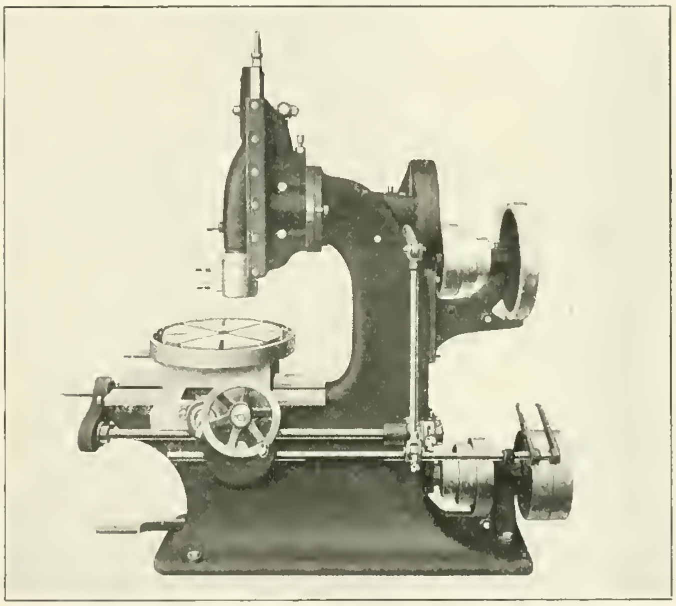
Slotting Machine for Tool Room Work

THE slotting machine illustrated has a 6½-in. stroke and on account of its general adaptability and the arrangement for swiveling the ram, the machine is well adapted for a large variety of tool room work. Taper keyways and other taper work, such as often occurs in machining dies and heavy tools can be performed without difficulty. Many machine operations on special jigs and fixtures can also be performed on this type of slotter.

The machine is cone-driven and of sufficiently rigid construction for any work within its capacity. With a proportionately heavy base and column, ample strength is insured and vibration is reduced to a minimum. Automatic feeds are provided to move both the longitudinal and transverse slides and the circular table. The table, of relatively large diameter, is graduated in degrees and has a locking device with 12 divisions. Swiveling the ram greatly increases the usefulness of the machine for all kinds of taper work and the swiveling arrangement is simple as shown in the illustration.

A universal tool holder of the clapper type is provided. All gears are mounted rigidly and the bearings are dustproof and oiltight. The countershaft is self-contained and the treadle brake shown projecting beneath the table enables the operator to stop the machine with the ram in any desired position.

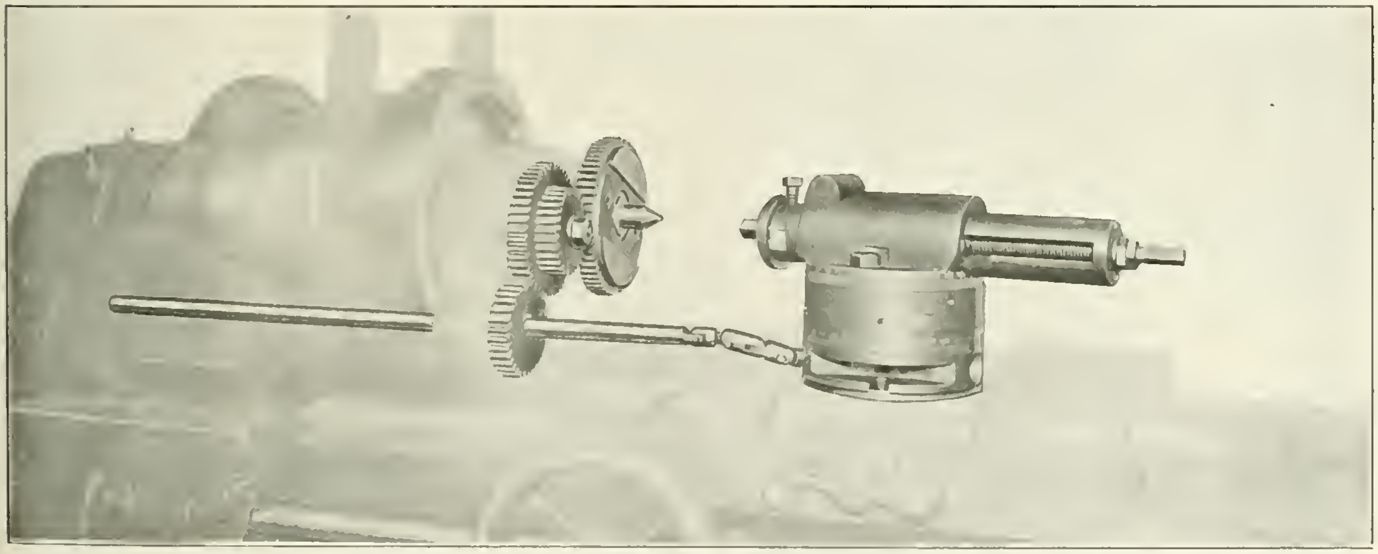
The stroke of the ram is 6½ in. and work 7½ in. high can be placed on the table. The maximum diameter of work that can be machined is 30 in. but the effective diameter of the rotary table is 16 in. The longitudinal and transverse travels are 12 in. each, and the speed ranges from 26 to 77 strokes per minute. The machine is manufactured by Harry F. Atkins, Peterborough, England, and is being placed on the American market by Alfred Herbert, Ltd., New York.



Atkins Slotting Machine With 6½ in Stroke

Fullswing Relieving Attachment for Lathes

SEVERAL new features have been included in the heavy duty relieving attachment illustrated, by means of which it is possible to perform a class of work not usually attempted on this type of lathe attachment. Interior relieving work may be mentioned as an example and in addition, all kinds of outside relieving work, including any angle, side, face, interior or irregular face flutings and taper cutting can be performed. Designed to stand hard machine shop usage,



Relieving Attachment Designed for Accuracy Under Heavy Cuts

the Fullswing relieving attachment is made in three horizontal sections, two of which remain stationary after alinement. They can be applied to any lathe equipped with a compound rest. The sections are graduated for angles of any degree and the tool holders can be moved for any axis of motion without reference to the tool. The relieving head is mounted on the single base in place of the compound rest and is driven from the nose of the headstock by a mounted gear through a train of gears as indicated. A universal joint between the spliced shaft and the relieving head allows for movement of the cross slide.

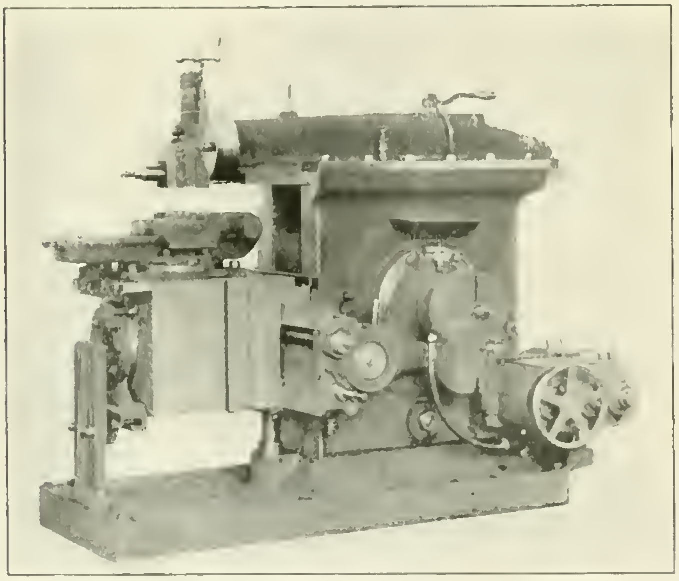
The entire mechanism is direct geared or stationary, with the exception of the reciprocating tool holder which operates in a V-guide, provided with a bronze gib. This direct connection saves lost motion and increases the accuracy and sensitiveness. A hand cross feed of three inches is provided on the tool holder for cross relieving, either straight or at an angle, thus permitting a class of work not usually attempted. Another distinctive feature is the provision in the tool holder for the vertical adjustment of the tool bit with a range of 3/8 in.

The attachment will operate in connection with the taper attachment of the lathe for relieving conical cutters and pipe reamers. Form contour cutters can be relieved when desired. A standard relief of 1/10 in. is provided, but special cams can be furnished for a greater or lesser relief. A set of four cams with one, two, three and four steps is furnished with each attachment for the operation of various flutings. A set of special gears can be furnished to relieve special formed cutters. In tool rooms and machine shops that manufacture milling and other cutters, the Fullswing relieving attachment can be used to good advantage.

Modern Refinements in Shaper Design

THERE has been a continual refinement in machine tool design in recent years to make the machines not only more efficient but adaptable to a greater variety of machine operations. The shaping machine has been no exception to this rule, and many improvements are included in the 24-in. heavy duty crank shaper manufactured by the Columbia Machine Tool Company, Hamilton, Ohio. Among these improvements may be mentioned the adaptability to either single pulley or motor drive. Additional features include a speed box, friction clutch and brake and revolving table having an outer support to provide additional stiffness.

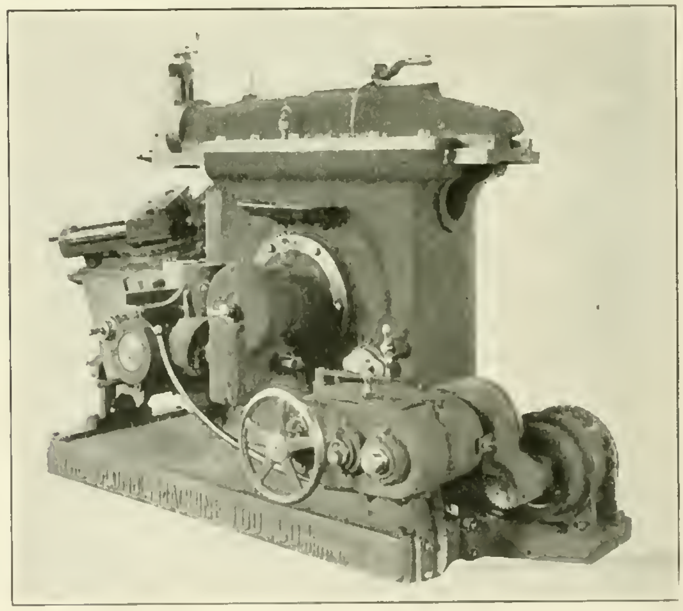
The speed box provides four changes of speed, or eight changes in connection with the back gears. The friction clutch and brake enables the machine to be started or stopped quickly at any point of the stroke. By special design the feed box is included as part of the machine and not as an attachment, and the arrangement provides a rigid and efficient feed device. Twelve feed changes are provided, ranging from



Columbia 24-In. Shaper With Modern Improvements

1/54 in. to 3/16 in. The feed takes places only on the return stroke and the mechanism automatically adjusts itself to the position of the cross rail.

Arrangements for either motor drive or single pulley drive can be made with slight alterations. In case a motor drive is desired, the power from a direct current motor is transmitted to the speed box through a rawhide gear, as illustrated. With the single-pulley drive arrangement, the main shaft of the speed box is simply extended through an additional bracket on the other side of the shaper. This allows the single pulley to be mounted on the outside and driven from the line shaft. The advantage of a friction brake in stop-



View Showing Adaptability to Motor Drive

ping the shaper in any desired position of the ram is self-evident.

Important advantages in the crank gear construction are its liberal proportions and the fact that it is carried close to the rocker arm, thus reducing tortional strain to a minimum. The rocker arm also is of heavy construction, the sides being joined by a strong central tie. It is connected to the ram through a heavy link, which affords a direct pull on the ram.

The revolving table is plainly illustrated, and a noteworthy feature is the construction of the outer support which stiffens the table and maintains the alinement of the faces. In addition to the outer support, the table is carried on a hub, or trunnion, of large diameter, which is bolted securely to the saddle. The table rotates on this trunnion and is graduated at the outer end so that it can be set at any desired angle. A rugged double screw vise with graduated swivel base is regularly furnished with the machine, but a single screw vise can be furnished if desired. The vise jaws are steel faced and suitable clamp screws prevent the movable jaw from lifting. On the double screw vise the jaws are offset to facilitate holding work alongside the table, if required.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue, 12,350 copies were printed; that of these 12,350 copies, 11,423 were mailed to regular paid subscribers, 10 were provided for counter and news company sales, 229 were mailed to advertisers, 32 were mailed to employees and correspondents, and 656 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 61,150, an average of 12,230 copies a month.

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The Texas & Pacific machine shop at Big Springs, Tex., is reported to have been destroyed by fire on March 29. Steps will be taken at once to rebuild the shops on a larger scale.

The Canadian Pacific has offered, subject to competitive examination, a free scholarship covering four years' tuition in either architecture, chemistry, civil, mechanical or electrical engineering at McGill University, Montreal, to apprentices and other employees enrolled on the company's permanent staff under 21 years of age and to sons of employees under 21 years of age.

It is reported that plans for largely increasing the number of workmen employed at the Americus, Ga., shops of the Seaboard Air Line are under consideration by officers of the company. The only other shops of the system are located in large cities and the belief that labor difficulties are less likely to occur in small industrial centers is said to be the reason for rehabilitating the Americus shops.

D. B. Hanna, president of the Canadian National, is preparing to lay before the Canadian Parliament an extensive program for increased efficiency and betterment of equipment of the Canadian National. Complete details will not be made public until the matter is laid before the Parliament at the coming session. Beyond stating that there would be no curtailment of last year's appropriations, Mr. Hanna has declined to make any further statement.

The following railroads have ordered a total of 87 of the total of 200 Decapod locomotives originally built for the Russian government, which the War Department has been trying to sell: Western Maryland, 10; Detroit, Toledo & Ironton, 15; St. Louis-San Francisco, 10; Atlantic Coast Line, 10; Charleston & Western Carolina, 3; Norfolk Southern, 4; John Ringling, 5; Seaboard Air Line, 20; St. Louis, Brownsville & Mexico, 5, and Nashville, Chattanooga & St. Louis, 5.

Domestic orders for locomotives up to the third week in March totaled 635, as compared with 1,048 in 1917, 926 in 1916, and 174 in 1915. This means, of course, that the volume of business this year, from the standpoint of number of locomotives ordered, has not been as great as in 1917 or 1916. It can also be taken to mean, in view of the underlying conditions, that the difference in volume as between this year and the two years, 1916 and 1917, has still to be made up and may eventually be added to the totals for the present year.

American Machine Tools in the Dutch East Indies

American machine tools are rapidly gaining an enviable reputation in this market, writes Consul Harry Campbell, Soerabaya, Java. One of the largest and most successful machine shops in Soerabaya is completely equipped with modern American machine tools and is securing an abundance of orders for shopwork which, it appears, it is able to fill more satisfactorily than any of its competitors. It is announced that this concern has recently been awarded the contract for the iron and steel work of a new government railway terminal at Tandjong Priok, the port of Batavia. This speaks well for the Soerabaya shop, with its American equipment, in view of the competition of Batavia firms located so much nearer the work.

Plans for Use of $300,000,000 Loan Fund

Plans for the use of the $300,000,000 revolving fund, placed at the disposition of the Interstate Commerce Commission to make loans to railroads, were discussed at a conference on March 25 by a committee representing the Association of Railway Executives with Commissioners Clark, Meyer, Daniels and Eastman, Director General Hines and R. B. Leffingwell, assistant secretary of the treasury.

Among the questions discussed was as to whether most of the available sum would be used to greatest advantage if invested in terminal improvements, etc., or in equipment.

It is understood that the executives, represented by T. De Witt Cuyler, Samuel Rea, Howard Elliott, Daniel Willard, Henry Walters and Alfred P. Thom, were inclined to urge the use of the fund largely for equipment, both because of the great need for it and because equipment can be purchased for a 25 per cent initial payment, and the fund would, therefore, accomplish more than if used otherwise.

The purchase of 80,000 freight cars, 20,000 refrigerator cars, 2,000 passenger cars, and 2,000 locomotives was discussed.

The railroads' program of capital expenditures also de-

pends on how soon they can collect from the Railroad Administration for rental due. Director General Hines is expected to ask Congress soon for an appropriation of over $400,000,000, which will enable him to make further payments to the roads.

Catalogues for Mesopotamian Railways

The Department of Overseas Trade, 35 Old Queen street, S. W. 1, advises that it has received information to the effect that the superintendent of stores of the Mesopotamian railways, in order to facilitate the preparation of demands and also for his general guidance, is desirous of obtaining copies of manufacturers' catalogues dealing with all kinds of railroad equipment and machinery, including locomotives and rolling stock, standard, meter gage and narrow gage; steam and oil pumps of all descriptions; motor rail cars, machinery—workshop, repair and manufactory; heavy and light tools as used on railways; lights, piping and fittings; general hardware; cranes; general electrical plant and accessories; engines—stationary and portable, steam and oil; conveyors, elevators, etc.; labor-saving devices generally. The catalogues should be forwarded directly to the superintendent of stores, Mesopotamian Railways, Makinah, Mesopotamia.

Italy Looking to Germany for Locomotives

Italy, which during the past two or three years has placed large orders for locomotives in the United States, is now looking to Germany as a source of supply. The reason for this, as explained in Commerce Reports in a communication from Alfred P. Dennis, commercial attaché at Rome, is the low purchasing power of the Italian lira in the American market. "It is a question," says Mr. Dennis, "how soon Germany will be able to satisfy any foreign demands of this sort, however. At the conclusion of the war that country possessed between 12,000 and 13,000 locomotives, 4,000 of which the allies took under the terms of the peace settlement; so that today Germany stands in more acute need of locomotives than does Italy. The situation in Italy is such that for the time it must continue to purchase from foreign sources, and until Germany is prepared to supply the demand the United States must be relied upon, in spite of unfavorable exchange, for whatever locomotives are imperatively needed."

Use of Air Brakes on Swedish Railways

Some few months ago, writes Consul General D. I. Murphy, Stockholm, the Swedish State Railways began to equip their rolling stock with Kunze-Knorr air brakes, a German invention. By the end of this year it is expected that 60 locomotives and 1,000 cars will be equipped with them. A project is before the Riksdag to grant an increased appropriation so that all the rolling stock of the State Railways, consisting of 1,100 locomotives, 2,500 passenger cars, and about 27,000 freight cars, may be provided with this particular brake.

The Swedish newspapers express gratification that the Kunze-Knorr brakes are to be manufactured by Aktiebolaget Nordiska Armaturfabrikerna, at Lund, that company having purchased the manufacturing rights for Sweden, Norway, and Denmark. The private railways in Sweden have been undecided as to the adoption of the air brake system, but the papers announce that there is no longer any doubt as to its adoption.

Division of Purchases Discontinued

The Division of Purchases of the United States Railroad Administration was discontinued on April 1. Henry B. Spencer, director of the division, who has been elected president of the Fruit Growers' Express Company, will become an advisory member of the director general's staff with respect to matters growing out of purchases during the period of federal control of railroads. Such portions of the work of the Division of Purchases as remained to be completed after April 1, with the exception of the completion of activities incident to control over the distribution of coal, are under the direction of the Division of Liquidation of Claims; Max Thelen, director.

Control over the distribution of coal, growing out of the strike of bituminous coal miners, was ended on April 1, in accordance with an executive order of the President. Work remaining to be done in connection with the winding-up of the matters relating thereto is being dealt with in the director general's office, through Brice Claggett, assistant to the director general.

Italy to Use Liquid Fuel for Railway Locomotives

An article in the London Times Trade Supplement says that in consequence of the scarcity and high cost of coal, the Italian Minister of Railways has ordered the immediate remodeling of 100 locomotives for use with liquid fuel. If the results are satisfactory, a further 200 locomotives will be adapted.

In Verona and Florence trials are being made with oil and coal mixed, and in Naples with oil only. Fourteen locomotives have been remodeled and are in use between Brindisi and Bari. All tests made hitherto have been very satisfactory.

The use of liquid fuel on a large scale is the only means of replacing coal quickly, as the electrification of railways can only be carried out in the course of some years. The Italian experiment must be regarded as an attempt to cope with one of the most important economic problems of the immediate future.

MEETINGS AND CONVENTIONS

Pacific Railway Club.—At its annual meeting held in San Francisco, Cal., on March 16, the Pacific Railway Club elected the following officers for the ensuing year: President, Dennistoun Wood, assistant mechanical engineer and engineer of tests, Southern Pacific; first vice-president, G. H. Harris, general superintendent, San Francisco—Oakland Terminal; second vice-president, F. S. Foote, Jr., professor of railroad engineering, University of California; treasurer, G. H. Baker, assistant general freight agent, Atchison, Topeka & Santa Fe; secretary, William S. Wollner, general safety and welfare agent, Northwestern Pacific.

National Machine Tool Builders' Association.—The annual convention of this association, of which Albert E. Newton, vice-president and general manager of the Reed-Prentice Company, Worcester, Mass., is the president, will be held at Atlantic City on May 20 and 21. At the same time the American Supply & Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the National Supply and Machinery Dealers' Association will also meet at Atlantic City. Many machinery manufacturers and dealers from all over the country will be represented.

American Foundrymen's Association.—A new department to be known as the Non-Ferrous Casting Section, will be added to the program of the next annual meeting of the American Foundrymen's Association, which will be held in Columbus, Ohio, on October 4 to 8, inclusive. At the meetings of this section papers and discussions of interest to practical brass and aluminum foundrymen will be presented. It is proposed to hold joint sessions also with the Institute of Metals Division of the American Institute of Mining & Metallurgical Engineers, which will hold its convention in Columbus during the same week. The other sections that will

be represented on the program of the American Foundrymen's Association are the Gray Iron, Steel Foundry, Malleable Iron and Industrial Relation Sections, and in conjunction with these meetings will be held the usual exhibit of foundry and machine shop tools, equipment and supplies.

Exhibit at Atlantic City

The exhibit at Atlantic City during the conventions of Section III—Mechanical, and Section VI—Purchases and Stores, American Railroad Association, will be a record-breaker in all respects. Arrangements are being made to place exhibits in the balcony of the main building, thus increasing the total square feet of exhibit space from 93,499 in 1919 to 99,817 ft. this year. Space has been allotted to 335 exhibitors as compared to 301 last year. There are applications for at least 30,000 sq. ft. of space in excess of the total amount available; the Exhibit Committee found it necessary in many instances to cut down the amount of space allotted to some of the applicants in order to take care of a large number of exhibitors. The only way in which additional exhibitors can be taken care of will be by making some arrangement to double up with exhibitors who have already been allotted space.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention May 4-7. Hotel Sherman, Chicago.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Convention, June 9-16, 1920, Atlantic City, N. J.

American Railroad Association, Section VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Convention June 14-16, 1920, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind. Convention June 1-4, 1920, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meetings second Tuesday in month, except June, July and August.

Car Foremen's Association of Chicago.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Friday in January, March, May and September and second Thursday in November, Hotel Statler, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago. Convention, May 24-27, 1920, Hotel Sherman, Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention Sept. 7-10, 1920, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meetings second Tuesday in month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Meetings third Friday in month, except June, July and August, 29 W. 39th St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings, second Thursday in month, alternately in San Francisco and Oakland.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings, fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Meetings, second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

Western Railway Club.—J. M. Byrne, 916 West 78th St., Chicago. Meetings, third Monday in month, except June, July and August.

PERSONAL MENTION

GENERAL

W. A. Cotton, formerly assistant to the general mechanical superintendent of the Erie, at Meadville, Pa., has been appointed mechanical accountant, with the same headquarters.

G. S. Edmonds, shop superintendent of the Delaware & Hudson at Colonie, N. Y., has been appointed acting superintendent of motive power, succeeding J. H. Manning, deceased.

J. E. Ennis, corporate assistant engineer of rolling stock of the New York Central Lines, with headquarters at New York, has been appointed engineer of equipment claims, the former corporate title of engineer of rolling stock having been abolished.

Alfred E. Calkins, who has been appointed superintendent rolling stock of the New York Central, lines east of Buffalo, with headquarters at New York, as noted in the April issue, served as engineer rolling stock of the New York Central and the Rutland during the greater part of federal control. Mr. Calkins began railroad work on January 7, 1892, as stenographer in the transportation department of the New York Central. On March 5 of the same year he was transferred to the general office of the mechanical department. He became chief clerk in the car shop at Rochester, N. Y., on February 15, 1898. On September 1, 1899, he was again transferred to the general office of the mechanical department as assistant chief clerk of the car department and in 1903 he was promoted to chief clerk. Afterwards he was appointed assistant to the superintendent of rolling stock and on August 1, 1918, he became engineer of rolling stock, which position he retained until his recent appointment.

A. E. Calkins

C. A. Gill, superintendent maintenance of equipment of the Baltimore & Ohio, at Baltimore, Md., has been appointed superintendent motive power of the Eastern lines, with the same headquarters.

T. F. Howley, superintendent locomotive operation of the Erie, with headquarters at Meadville, Pa., has been appointed special agent, with the same headquarters.

D. L. Mills, roundhouse foreman of the Chicago & North Western, has been appointed chief draftsman of the motive power and car departments, succeeding L. P. Michael.

B. B. Milner, engineer of motive power of the New York Central, with office at New York, has been appointed engineer of motive power and rolling stock, and will be responsible for the design and construction of new equipment (other than electric), standards for repairs, testing equipment, supplies and materials.

John L. Mohun, assistant to E. E. Adams while consulting engineer of the Union Pacific at New York, has been

appointed mechanical assistant, with headquarters at Omaha, Neb. Mr. Mohun began railroad work as an apprentice in the Altoona shops of the Pennsylvania. Afterwards he became assistant master mechanic of the Juniata shops. He was then appointed assistant engineer of motive power and master mechanic of the New Jersey division with headquarters at Jersey City, N. J. He became assistant to the consulting engineer of the Union Pacific, with headquarters in New York in 1914.

Charles I. Hyland has been appointed mechanical superintendent of the Toledo Terminal with headquarters at Toledo, Ohio. He served as chief boiler inspector of the Michigan Central from January 15, 1919, until the termination of federal control. Mr. Hyland was born on November 3, 1874, at Detroit, Mich. He was graduated from the high school at Jackson, Mich., and began railroad work as an apprentice for the Michigan Central in August, 1891. He was promoted to foreman of the boiler department in July, 1906, and left railroad service in November, 1913, to become boiler expert for the Flannery Bolt Company. He returned to the Michigan Central in 1919 as chief boiler inspector with headquarters at Detroit, Mich.

C. I. Hyland

W. K. Lynn, master mechanic of the Gulf & Ship Island at Gulfport, Miss., has been appointed superintendent, with headquarters at Hattiesburg, Miss., succeeding M. D. Fohey.

L. P. Michael, whose appointment as mechanical engineer of the Chicago & North Western, with headquarters at Chicago, was announced in the April *Railway Mechanical Engineer*, was graduated from Purdue University as a bachelor of science in mechanical engineering, specializing in railroad work, in 1896. He was first employed for about one year as a locomotive fireman by the Wabash and Monon Railways, later working as a special machinist helper in the shops of the Monon at Lafayette, Ind. He was then for eight years in the service of the Cleveland, Cincinnati, Chicago & St. Louis and during that time held the positions of machinist, air brake foreman, erecting foreman, enginehouse and general foreman, draftsman and inspector of shops and machinery. Since 1906 he has been with the Chicago & North Western, being employed as a draftsman until 1908, when he was promoted to the position of chief draftsman of the motive power and car departments and held this position until he was recently appointed mechanical engineer.

L. P. Michael

George C. Jones, whose appointment as general road foreman of engines of the Atlantic Coast Line, with headquarters at Florence, S. C., was announced in the April *Railway Mechanical Engineer*, was born on August 2, 1874 at Fayetteville, N. C., and was educated at Donaldson Academy, Fayetteville. He began railroad work in the shops of the Cape Fear & Yadkin Valley Railway and later acted as a fireman and engineman on that road until it was purchased by the Atlantic Coast Line. He continued as an engineman with that road until December 20, 1909, when he was promoted to the position of road foreman of engines and on March 1, 1920, to his present one as general road foreman.

G. C. Jones

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. P. Barnes has been appointed master mechanic of the Colorado, Wyoming & Eastern, succeeding A. D. Howard, resigned.

J. L. Butler, master mechanic of the Missouri Pacific at DeSoto, Mo., has been transferred to the position of master mechanic of the St. Louis (Mo.) terminals of the Missouri Pacific.

John J. Mulreney, general foreman of the North division of the Detroit & Mackinac, has been appointed master mechanic, with headquarters at East Tawas, Mich., succeeding H. T. Thomas. Mr. Mulreney was born on August 15, 1861, at Houghton, Mich., and received his education in the public schools of Jackson. Since June, 1879, he has been engaged in railroad work, having first been employed for three years in the shops of the Michigan Central at Jackson. He then went to Bay City and remained in the employ of that road until September 10, 1889, since which time he has been with the Detroit & Mackinac. In April, 1895, he was appointed general foreman of the North Division at Alpena, Mich., and acted in that capacity continuously from that time until he received his recent appointment.

J. J. Mulreney

F. G. Fisher has been appointed assistant master mechanic of the St. Louis-San Francisco at Monett, Mo., succeeding W. J. Foley, transferred.

W. J. Foley, assistant master mechanic of the Northern division of the St. Louis-San Francisco at Monet, Mo., has been appointed master mechanic at Enid, Okla., succeeding A. J. Devlin.

G. B. Jefferis has been appointed road foreman of engines of the Stockton division of the Southern Pacific, with headquarters at Tracy, Cal., succeeding W. R. Parker, transferred.

G. H. Langdon, shop superintendent of the Virginian at Princeton, W. Va., has been appointed master mechanic, with the same headquarters, and the title of shop superintendent has been abolished.

W. R. Parker, road foreman of engines of the Southern Pacific at Stockton, Cal., has been transferred to West Oakland, Cal., succeeding E. E. House, retired because of ill health.

W. C. Ross, master car builder of the Copper Range, has been appointed master mechanic at Houghton, Mich., succeeding N. M. Barker, resigned to engage in other business.

CAR DEPARTMENT

James Reed, who has been appointed master car builder of the New York Central, fourth district (west), with headquarters at Englewood, Ill., as noted in the April issue, served from 1913 until the termination of federal control as assistant master car builder of the same road, with headquarters at Chicago. Mr. Reed was born in 1869 at Utica, N. Y. He received a public school education and began railroad work in 1888 as car repairer on the Rome, Watertown & Ogdensburg, now part of the New York Central, at Utica. In 1891 he entered the employ of the New York Central as inspector at Herkimer, N. Y., and in 1892 he was transferred to Malone, N. Y., as foreman inspector. While serving in that capacity he was stationed at Lyons, N. Y., from 1896 until 1897, and at Rochester from 1897 until 1902, when he became chief joint inspector at Buffalo.

SHOP AND ENGINEHOUSE

Charles P. Bond, whose appointment as foreman of the centralization plant of the Erie at Meadville, Pa., was announced in the March *Railway Mechanical Engineer*, received his education in the Carnegie Technical School, Pittsburgh, Pa. His entire railroad work has been with the Erie, he having entered the employ of that road about 17 years ago as a machinist apprentice. Two years ago he was promoted to the position of shop demonstrator, which he held at the time of his recent appointment.

A. J. Devlin, master mechanic of the Western division of the St. Louis-San Francisco at Enid, Okla., has been appointed shop superintendent of the North shops at Springfield, Mo., succeeding J. E. Henshaw, transferred.

F. H. Jenkins has been appointed locomotive foreman of the Canadian Pacific, with headquarters at Brownville Junction, Me.

E. P. Poole has been appointed supervisor of shops of the Baltimore & Ohio, with headquarters at Baltimore, Md.

PURCHASING AND STOREKEEPING

L. V. Guild has been appointed purchasing agent of the Union Pacific, succeeding G. H. Robinson, transferred.

Alonzo Ross has been appointed superintendent of stores of the New York region of the Erie, with headquarters at Jersey City, N. J.

OBITUARY

Henry B. Brown, superintendent of the fuel department of the Lehigh Valley, died suddenly at his home at Bethlehem, Pa., on April 1, aged 62 years. Mr. Brown was formerly general fuel inspector of the Illinois Central.

Harry Osborne, formerly works manager at the Angus shops of the Canadian Pacific, died at Montreal on March 17, 1920, aged 61.

SUPPLY TRADE NOTES

A new office has been opened by Alfred Herbert, Ltd., New York, at 31 Yonge street, Toronto, Canada, in charge of J. C. Blair.

J. F. Griffin has been appointed chief draftsman of the Locomotive Feed Water Heater Company, 30 Church street, New York.

The Chambers Valve Company, New York, has removed its office from 30 Church street to room 1017, 23 West Forty-third street.

The Bradford Draft Gear Company has removed its New York office from 30 Church street, to suite 1018, 23 West Forty-third street.

Charles C. Kilander, Chicago manager of the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., died on March 18.

The Pennsylvania Tank Car Company and the Pennsylvania Tank Line have removed their New York office from 50 Church street to 25 West Forty-third street.

The Cincinnati Grinder Company is planning a two-story addition in the rear of its plant, 3233 Colerain avenue, Cincinnati, the dimensions being 107 ft. by 60 ft.

Charles A. Beider, assistant manager of sales of the National Malleable Castings Company, Cleveland, Ohio, died in that city on March 13, at the age of 35 years.

M. C. M. Hatch, formerly with the Pulverized Fuel Equipment Corporation, New York, has become associated with the Railway & Industrial Engineers, Inc., 25 Broad street, New York.

John Jeppson, one of the founders of the Norton Company, Worcester, Mass., and for many years a director and superintendent of the plant, died suddenly in Havana, Cuba, on March 26.

A. A. Roelofs, formerly special representative in the Ohio territory, of the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa., has been made manager of the Chicago office of the company.

Fred J. Passino, who for many years has represented the Independent Pneumatic Tool Company in the Southwest, has been appointed assistant manager of the Eastern division, with headquarters in New York.

Stewart H. Ford recently opened an office at 608 Mutual building, Richmond, Va., and is engaged in the railway supply business, specializing on the Rees car and journal jacks and Hisey-Wolf electric portable tools.

The Mahr Manufacturing Company, Minneapolis, Minn., is now represented in western Pennsylvania by J. L. Edwards, with an office at 498 Union Arcade building, Pittsburgh, Pa. Mr. Edwards succeeded J. S. Longnecker.

J. F. Kroske, who served as a lieutenant with the Nineteenth Engineers during the war, has taken a position in the service department of the Ingersoll-Rand Company, New York, and is connected with its Pittsburgh office.

The Morris Machine Tool Company, Cincinnati, Ohio, has bought the business of the American Metal Products Company, also of Cincinnati, manufacturer of screw-machine products, automobile starting cranks and drag links.

The Morse Chain Company, Ithaca, N. Y., has opened two additional branch offices, one at 1402 Lexington build-

ing, Baltimore, Md., in charge of E. R. Morse, and the other at 302 Harrison building, Philadelphia, Pa., in charge of M. H. Rodda.

The Hydraulic Press Manufacturing Company, Mt. Gilead, Ohio, has opened a branch office in the Mutual Life building, Buffalo, N. Y., in charge of R. K. Havlicek, who for some time has represented the company as a sales engineer, with office at Mt. Gilead.

W. W. Williams, general manager of the Reading Iron Company, Reading, Pa., has been elected vice-president in charge of sales and operation and J. M. Callen, second vice-president, has been elected vice-president in charge of purchases and distribution of materials.

The Curtain Supply Company, Chicago, has taken over the manufacture and sale of the steam and electric railway devices formerly made and sold by the Forsyth Brothers Company, Harvey, Ill., and is increasing the capacity of its plant to care for the additional business.

Joseph R. Beatty, manager of the Fairbanks Company, Boston, died recently at his home in Newtonville, Mass. He was born in Philadelphia January 27, 1863. His connection with the Fairbanks Company started in 1896 in Philadelphia, and in 1902 he went to Boston as manager there.

The Black & Decker Manufacturing Company, Towson Heights, Baltimore, Md., announces the establishment of a permanent office and showroom at 1436 South Michigan avenue, Chicago, Ill. This office will be in charge of R. G. Ames, whose territory has been extended to cover the middle West.

Leslie R. Pyle, whose election to the vice-presidency of the Locomotive Firebox Company, with headquarters at Chicago, was announced in *Railway Mechanical Engineer* for April, was born at Cleveland, Ohio, on June 7, 1880. He entered railway service on February 6, 1906, as a locomotive fireman on the Minneapolis, St. Paul & Sault Ste. Marie. On June 1, 1909, he became an engineman, and from 1912 to 1913 was traveling fireman. On May 1, 1913, he was appointed a fuel supervisor, which position he retained until July 1, 1918, when he was appointed supervisor of the Fuel Conservation Section, Division of Operation, United States Railroad Administration. This position he retained until March 1, 1920, when he was elected to the vice-presidency of the Locomotive Firebox Company.

L. R. Pyle

The Oxweld Acetylene Company, Newark, N. J., has taken over the manufacture of the Prest-O-Lite welding and cutting equipment. This apparatus, with certain refinements of design, is now being manufactured by the Oxweld Acetylene Company under the name of Eveready welding and cutting outfits.

Joseph T. Ryerson & Son, Chicago, have made an arrangement with the Camden Iron Works, Camden, N. J., to become the selling representatives of that company, which is engaged in manufacturing hydraulic tools, centrifugal pumps, cast iron pipe and fittings, gas holders and kindred products.

The Triangle Equipment Company has been organized to deal in railway and contractors' equipment of all descriptions, with headquarters in the Munsey building, Washington, D. C. The officers are W. P. Gleason, president; Richard E. Lewis, manager, both previously with the Pennsylvania Railroad, and Anderson Allyn, treasurer, formerly with the director of sales, War Department.

J. C. Little, mechanical engineer of the Chicago & North Western, with headquarters at Chicago, has resigned to enter the service of H. G. Doran & Co., Chicago representatives of the Schaefer Equipment Company, the Clark Car Company and the Mason Tanking Company, all of Pittsburgh, Pa.; Benson & Co., New York, and the Rivet Cutting Gun Company, Cincinnati, Ohio. Mr. Little was born at Dunkirk, N. Y., on August 20, 1871, and was educated at Stanford University, Palo Alto, Cal. He began railway work with the Brooks Locomotive Works, now a part of the American Locomotive Company. In March, 1903, he went to St. Paul, Minn., as a draftsman for the Northern Pacific, and later was promoted to chief draftsman. In 1904 he was appointed chief draftsman on the Louisville & Nashville, with headquarters at Louisville, Ky., retaining that position until September, 1906, when he was appointed mechanical engineer of the Chicago & North Western.

J. C. Little

The New Britain Machine Company, New Britain, Conn., announces the election of the following officers: F. G. Platt, chairman of the board of directors; H. H. Pease, president and treasurer; A. Buol, vice-president; S. T. Goss, vice-president; C. R. Hare, vice-president; R. S. Brown, Secretary; and H. E. Erwin, assistant secretary.

D. Gleisan, manager, industrial bearings division of the Hyatt Roller Bearing Company, New York, announces that its offices have been removed from 1 Madison avenue to 100 West Forty-first street, New York, where much larger headquarters have been secured for the advertising, sales and engineering department of the division.

The Thomas Spacing Machine Company, Pittsburgh, Pa., has opened an office in Philadelphia, at 57 Transportation building. G. L. Bohannon will be in charge of this office and will handle the company's entire line of equipment. He was formerly chief engineer and assistant general manager of the Youngstown Steel Car Company.

The Rickert-Shafer Company, Erie, Pa., announces the following appointments: A. A. Shafer, secretary and general manager; C. W. Howard, formerly with the General Electric Company, general sales manager; A. J. Patterson, formerly with the Crucible Steel Company, general superintendent; and George Paterson, production manager.

Charles A. Coons resigned as secretary and treasurer of the Paxton-Mitchell Company, Omaha, Neb., on April 1, to enter the railway supply business in Omaha. Mr. Coons was connected with the Paxton-Mitchell Company for the last 14 years and prior to that time was in the motive power and car department of the Union Pacific for 20 years.

The Campbell-Howard Machine Company, formerly the Sherbrooke Iron Works, Ltd., Sherbrooke, Que., has been purchased by G. L. Bourne and F. A. Schaff, respectively president and vice-president of the Locomotive Superheater Company, New York. The company's plant will be utilized partially to manufacture railway supplies for Canadian railroads.

John N. Derby, vice-president of Manning, Maxwell & Moore, Inc., New York, died at his home in Greenwich, Conn., on March 29. Mr. Derby was born 53 years ago. He was a graduate of the University of Michigan, and in 1888 organized the Hayden & Derby Manufacturing Company in the state of Michigan. About 30 years ago he became associated with Manning, Maxwell & Moore, and the Hayden & Derby Manufacturing Company was afterwards absorbed by the United Injector Company. Mr. Derby, at the time Manning, Maxwell & Moore was incorporated, was made first vice-president, director and a member of the executive committee. His special end of the business was looking after the brass department, managing the sales of the Ashcroft Manufacturing Company, the Consolidated Safety Valve Company, and the Hancock Inspirator Company, and looking after the general railroad trade covering these lines. He was the inventor of the Metropolitan injector used on steam engines and locomotives.

J. N. Derby

The Koppel Car Repair Company has been organized recently as a subsidiary of the Koppel Industrial Car & Equipment Company, Koppel, Pa. The new company has a shop located on the property of the parent organization and is turning out four repaired cars a day and has capacity for the dismantling and prepairing for repair of about 30 cars at one time.

The Hulson Grate Company, Keokuk, Iowa, has been incorporated for the purposes of manufacturing and selling engine and locomotive appliances and devices. The amount of capital stock authorized is $100,000 and the incorporators and officers include: A. W. Hulson, president; B. D. Streeter, vice-president; J. W. Hulson, secretary-treasurer; C. R. Joy, and W. M. Hogle.

N. M. Barker, master mechanic of the Copper Range Railroad, at Houghton, Mich., has resigned to become mechanical superintendent of the American Automatic Connector Company, Cleveland, Ohio. He will have supervision of the manufacturing and installation of the connector this company is placing on the market, which is designed to automatically connect steam and air hose on freight and passenger cars.

The American Steam Conveyor Corporation, Chicago, announces the appointment of the Kon-Wald Engineering Company, Mutual Life building, Buffalo, N. Y., as its representative in Buffalo and western New York. F. A. Konzelman is manager of that company. The Brooks-Fisher Company, Chandler building, Atlanta, Ga., has been appointed southeastern representative. This company was organized early last summer to carry on a business of manufacturers, agents and contractors.

C. H. Martin and Gustav Schirmer, of the Whiting Foundry Equipment Company, Harvey, Ill., after serving for several years in its estimating and sales department at the main office, have been respectively transferred to its Pittsburgh and Detroit offices, to take up the duties of sales engineers. Both men are experienced engineers and are thoroughly familiar with the design and construction of cranes and foundry equipment.

H. U. Morton, vice-president of the Dunbar Manufacturing Company, Chicago, has been elected president of that company, succeeding Thomas Dunbar, who has resigned. The Dunbar Manufacturing Company, during the period of the war, was engaged entirely on war work and received an award for distinguished service for quantity production of artillery ammunition bodies. The company has resumed the manufacture and sale of its various railway appliances and is also in position to manufacture steel doors for cars, steel pressings, stampings and drawn steel shades.

George H. Snyder has been appointed sales engineer, with headquarters at St. Paul, Minn., of the American Steel Foundries, Chicago. He entered the service of the store department of the Minneapolis, St. Paul & Sault Ste. Marie as a clerk in 1905, and was promoted to chief clerk of the same department in 1909. He remained in that position until August 1, 1911, when he was transferred to the mechanical department and served as chief clerk under T. A. Fogue, general mechanical superintendent, until his new appointment with the American Steel Foundries.

Karl J. Eklund, general manager of Mudge & Co., has been elected vice-president in charge of sales and service. In this capacity Mr. Eklund will also have charge of western sales for the Pilliod Company, Swanton, Ohio, and the Chambers, Lyle Company. Mr. Eklund was born on July 8, 1884, and entered railroad service as a blacksmith's helper in the shops of the Boston & Maine. After three years as an appentice machinist he was employed on various railroads as a journeyman machinist. In 1908 he returned to the Boston & Maine as machinist and foreman in the Keene, N. H., shops, and on March 1, 1910, he became connected with the Pilliod Company as a valve gear inspector. On February 1, 1915, he was appointed assistant to the president of the Pilliod Company, with headquarters at New York City. He occupied this position until April 1, 1917, when he was appointed assistant to the president of Mudge & Co., Chicago, and served in this capacity until his appointment as general manager on March 1, 1918.

K. J. Eklund

The properties of the Southern Locomotive Valve Gear Company, Knoxville, Tenn., have been purchased by General L. D. Tyson (former president) and associates, and reorganized as the Southern Valve Gear Company, with ample capital and facilities to take care of any and all demands for Southern valve gears and Brown power reverse gears. The officers of the new company are: General L. D. Tyson, president; Forrest W. Andrews, vice-president; William Whaley, general manager, and H. P. Strayer, secretary. The headquarters of the new company are at Knoxville.

At the annual meeting of the Pratt & Letchworth Company, Buffalo, N. Y., on March 2, changes were made in the officers of the company as follows: John C. Bradley, who for a number of years has been president of the company, was elected chairman of the board of directors; John H. Bradley, general manager, was elected president and general manager; Franklin D. Locke, vice-president, was elected first vice-president; John P. Williams, who has been manager of sales, was elected second vice-president in charge of sales, and Willis M. Edwards was re-elected secretary and treasurer.

The leather belting plant and business of the Edward R. Ladew Company, Inc., Glen Cove, N. Y., has been bought by the Graton & Knight Manufacturing Company, Worcester, Mass., oak leather tanners and makers of leather belting. The operations of the Ladew organization will be continued as heretofore by the new owners. The plant of the Ladew Company comprises 10 modern buildings, with a floor area of 14 acres, and employs more than 600 persons. The company has branches in Boston, New York, Newark, Philadelphia, Charlotte, Pittsburgh, Cleveland and Chicago and distributors in all principal cities.

Walter H. Lovekin, for the past two years assistant to the president of the Locomotive Feed Water Heater Company, New York, has been elected vice-president and treasurer. He was born in Philadelphia, Pa., and received his education at the Haverford Preparatory School, Haverford, Pa., and Princeton University. After leaving Princeton he was employed for a time by the Logan Trust Company, Philadelphia, Pa., and by the Bell Telephone Company as a traffic inspector. He subsequently joined the Philadelphia Bureau of Municipal Research as a member of the staff, and served in this capacity for two and a half years. During this time he made detailed studies and surveys of various civic problems. After leaving this work he went with the R. J. Crozier Company, Philadelphia, as a salesman, handling railway, mill and mine supplies. On June 1, 1916, when the Locomotive Feed Water Heater Company was but two and a half months old, he entered its service, a few months later being appointed assistant to the vice-president, and in December, 1917, he was appointed assistant to the president, which position he held until his recent election as vice-president and treasurer. For the past two and a half years Mr. Lovekin, in addition to his other duties, has been in charge of the company's activities in the marine field. This involved the manufacture and delivery of feed water heaters, evaporators, boiler feed pumps, distillers and oil coolers for more than 550 ships built or building for the U. S. Shipping Board, Emergency Fleet Corporation. As vice-president he will continue in charge of the marine department and will be in charge of all sales and sales matters for the company, in addition to his duties as treasurer.

W. H. Lovekin

Charles C. Phelps has recently become associated with the Uehling Instrument Company, 71 Broadway, New York, combustion engineers and manufacturers of CO_2 recording equipment and other fuel economy apparatus. Mr. Phelps is devoting most of his attention to research work in connection with the efficient combustion of fuel oil in boiler furnaces. He graduated from Stevens Institute of Technology with the degree of mechanical engineer and has since been studying power plant problems, having been for five years associated with the Ingersoll-Rand Company, New York. Mr. Phelps is an associate member of the American Society of Mechanical Engineers.

Edward Wray has associated himself with Railway Materials as managing editor, with headquarters in Chicago. Mr. Wray was formerly managing editor and publisher of the *Railway Electrical Engineer* from its first issue in 1909 to 1916, when the magazine was purchased by the Simmons-Boardman Publishing Company, publishers of the *Railway Mechanical Engineer*. Mr. Wray continued his connection with the magazine as business manager, and later became associated with the Sangamo Electric Company, Springfield, Ill., as assistant general manager. He received his education at the University of Wisconsin, graduating in 1905, and received the degree of electrical engineer in 1906, following a year of special work devoted exclusively to the investigation of all of the various systems of lighting steam railroad cars by electricity. In carrying out this work Mr. Wray had the assistance of 10 electrical students of the senior class at the university. Mr. Wray is a member of the American Institute of Electrical Engineers, associated member of the Railway Storekeepers' Association and the Association of Railway Electrical Engineers, and has been treasurer of the Railway Electrical Supply Manufacturers' Association since its organization in 1909. Railway Materials, the paper of which Mr. Wray is now managing editor, was until recently know as the Railway Storekeeper. It is published by the former Railway Storekeepers' Association, now known as Section VI Purchases and Stores, of the American Railroad Association.

E. Wray

R. Rivett, supervisor of car repairs for the United States Railroad Administration, with headquarters at Washington, D. C., resigned on March 1 to enter the service of the Oxweld Railroad Service Company, New York, as district manager, with headquarters at Chicago. Mr. Rivett was formerly connected with the Chicago, Burlington & Quincy, entering the service of that railroad in 1881, and resigning in 1902 as general car foreman. Subsequently he was appointed general car inspector for the Union Pacific. He left the service of the latter road in 1910 to become general car inspector for the Illinois Central. In 1918 he became supervisor of car repairs for the Railroad Administration.

The Metal & Thermit Corporation, New York, in order to take care of its increasing business in the New England states and in Canada, has appointed James G. McCarty manager of its Canadian branch, with headquarters at Toronto, Ont., and has transferred Robert L. Browne from its New York office to Boston, Mass., where he will have charge of all sales in the New England states. Mr. McCarty was graduated from Stevens Institute of Technology in 1906, and became affiliated with the Metal & Thermit Corpora-

tion in 1909. He has had a wide and varied experience with all phases of the Thermit process and has represented the company in many sections of the United States and Canada. Mr. Browne has been associated with the New York office since 1917.

R. T. Walsh, general sales manager of the Sullivan Machinery Company, Chicago, for the past eight years, has been appointed vice-president in charge of sales and has also been elected a director. Mr. Walsh was born in Massachusetts and received his education at Worcester Polytechnic Institute, graduating in 1900. He entered the service of the Sullivan Machinery Company at Claremont, N. H., and after several months was assigned to the western branch of the company at Denver, Col., as a salesman. In 1906 he was appointed Pacific coast manager, with headquarters at San Francisco, Cal. He was promoted to European sales manager, with headquarters at London, Eng., five years later, and in 1913 he was appointed general sales manager, which position he held until his recent promotion.

Locomotive Stoker Company

A. C. Deverell has resigned as superintendent of motive power of the Great Northern, at St. Paul, Minn., to become western sales manager of the Locomotive Stoker Company, Pittsburgh, Pa., with office at Chicago. He was born in Montreal, Que., and after attending the public schools of that city began his career in the shops of the Grand Trunk at Montreal. He went west in 1895, and while performing some special work for Samuel Hill, president of the Eastern Minnesota Railway, came to the notice of the late James J. Hill, who appointed him superintendent of the freight car shops at St. Cloud, Minn. He was promoted to superintendent of the St. Paul locomotive and passenger car shops, the largest shops on the Great Northern system, employing approximately 19,000 men. He subsequently became assistant superintend of motive power and later served as superintendent of motive power until his recent appointment as western sales manager of the Locomotive Stoker Company.

H. C. Woodbridge has resigned as supervisor of the Fuel Conservation Section of the U. S. Railroad Administration to enter the service of the Locomotive Stoker Company as representative, with headquarters at Pittsburgh, Pa. He was born on October 7, 1874. He worked in the machine shops at Chatham, N. Y., and was extra fireman on the Lebanon Springs Railroad during 1891 and 1892. In 1897, he graduated as mechanical engineer from Cornell University. From June, 1897, to March, 1899, he worked as a machinist in the Minneapolis & St. Louis shops at Minneapolis, Minn. He was foreman at Albert Lea, in charge of locomotive and car work from March, 1899, to February 1903, but during the last two years of this period served as traveling fireman and extra locomotive engineman and pilot. In February, 1903, he was made traveling engineer and inspector for the American Locomotive Company, resigning in September, 1904, to take service as general foreman on the Delaware, Lackawanna & Western, at Elmira, N. Y., serving until November, 1905. He was appointed a master mechanic on the Buffalo, Rochester & Pittsburgh, in November, 1905, remaining in that position until January, 1908. From January, 1908, to August, 1909, he was occupied in special work for the superintendent of motive power, and was made special representative and assistant to general manager in August, 1909, remaining in that work until June, 1918. He was then appointed supervisor for the Allegheny region, Fuel Conservation Section, U. S. Railroad Administration, which position he recently resigned.

J. J. Byrne has been appointed district representative of the Locomotive Stoker Company, with his headquarters at new offices opened in Washington, D. C. He was born in Cincinnati, Ohio, and attended the publice schools of that city and Delaware, Ohio. He entered railroad service in 1903, in the Cleveland, Cincinnati, Chicago & St. Louis shops at Delaware, as machinist apprentice. After completing his apprenticeship, he entered the service of the New York Central Lines as machinist in the Collinwood shops. He remained in the employ of the New York Central until 1909, when he left to accept a position as mechanical expert with the Locomotive Stoker Company. In 1917 he was appointed representative with headquarters in New York, and the following year was transferred to the southern territory, with headquarters at Roanoke, Va. Later in the year he was located in Richmond, Va., in charge of the Locomotive Stoker Company's office at that place.

A. C. Deverell

W. C. Woodbridge

J. J. Bryne

The general offices of the Chicago Pneumatic Tool Company on March 31 were removed from Chicago to the Chicago Pneumatic building, a new 10-story structure erected for the exclusive use of the company, at 6 East Forty-fourth street, New York. The move was accomplished without appreciable interruption to business over the week-end. Arrangements, carefully made in advance, made possible the jump of the organization across half of the continent without interference to the normal routine of business except for a brief period. The Chicago district sales branch, previously in the Fisher building, has been moved to new quarters at 300 North Michigan boulevard. The Chicago service

branch, formerly at 521 South Dearborn street, has been consolidated with the sales branch, at the new address, and both departments are under the direction of J. L. Canby, district manager.

W. G. Walsh, notice of whose election as vice-president of the Galena Signal Oil Company, Franklin, Pa., with headquarters at Chicago, was announced in last month's issue, began railway service as an apprentice in the machine shops of the old Cleveland, Cincinnati, Chicago & Indianapolis, at Cleveland, Ohio. On the completion of his apprenticeship, he became a machinist on the Cincinnati, New Orleans & Texas Pacific at Somerset, Ky., and prior to 1890 was successively locomotive fireman, engineman and general mechanical instructor. In 1890 he was promoted to master mechanic of the Louisville division, with headquarters at Louisville, Ky., which position he retained until 1900, when he resigned to become mechanical expert for the Galena Signal Oil Company. In 1910 he was promoted to resident manager, with headquarters at Chicago, which position he retained until his recent election to the vice-presidency.

W. W. Frazier has recently been appointed assistant superintendent of the tube works of the Reading Iron Company, Reading, Pa. He began work as a draftsman and for four years served at the Loraine plant of the National Tube Company, both in the construction of its pipe mills and in the operating department. Later he served in an engineering capacity in the rearrangement of the pipe mills of the La Belle Iron Works and then went with the Youngstown Sheet & Tube Company, where for seven years he was first in the engineering department and later was general foreman of its tube mills. He was chief engineer of the A. M. Byers Company for one year, leaving that company to become assistant chief engineer at the government plant that was being built for the Ordnance Department by the U. S. Steel Corporation at Neville Island. When the armistice stopped work on this plant he went with the Bethlehem Steel Company, at Sparrows Point, as assistant chief engineer and recently became associated with the Reading Iron Company as assistant superintendent of its tube works.

J. S. Lemley, who for the past five years has been general sales manager of the G. F. Cotter Supply Company, Houston, Texas, has left that company to become associated with and a partner of W. D. Jenkins, Dallas, Texas, representative of manufacturers of railway equipment and supplies, with principal office at Dallas and offices also at Houston and New Orleans, La. Mr. Lemley will have full charge of all mechanical matters. He served on the Baltimore & Ohio in 1898 as a locomotive engineman and a short time later was promoted to trainmaster. After serving in this capacity for two years he went to the mechanical department of the Chicago, Milwaukee & St. Paul. Two years later he was appointed general supervisor of locomotive operation of the Baltimore & Ohio South-Western and the Cincinnati, Hamilton & Dayton, with headquarters at Cincinnati. After serving in that capacity for two years he went to the mechanical department of the Texas & Pacific, remaining with that road until July 1, 1915, when he became associated with the G. F. Cotter Supply Company. C. E. Naylor, who has been associated with Mr. Jenkins since 1916, and formerly served on the Texas & Pacific and the International & Great Northern in the mechanical and traffic departments, is in charge of the Houston office. R. L. Irwin is in charge of the New Orleans territory. Mr. Irwin was formerly purchasing agent of the Texas & Pacific, and during federal control of the railroads was purchasing agent of the lines under the jurisdiction of F. G. Pettibone as federal manager at Dallas, Tex. J. K. Bagley, formerly with the Texas & Pacific as chief clerk in the purchasing department, is in charge of the New Orleans office.

TRADE PUBLICATIONS

Union Fittings.—The E. M. Dart Manufacturing Company, Providence, R. I., has issued its 1920 catalogue (S) of unions and flanges, with illustrations, prices and schedules showing sizes, dimensions, weights, etc.

Time Zones.—The Metal & Thermit Corporation, New York, is distributing a large map and calendar for 1920, showing railroad time zones in the United States and Canada and illustrating a number of interesting repairs made with Thermit welding.

Locomotive Chart.—The Angus Sinclair Company, New York, has recently prepared a chart of a Pacific type locomotive showing a longitudinal cross section and a rear view of the interior of the cab. The detail parts are numbered and the names are given in a list printed on the sheet.

Air Compressors.—The National Compressed Air Machinery Company, San Francisco, Cal., has published a bulletin, No. 20, describing the construction of a vertical type air compressor and containing a table of dimensions and specifications of the various models built by this company.

Cranes.—The Whiting Foundry Equipment Company, Harvey, Ill., has issued a new edition of its crane catalogue, designated as catalogue No. 151, containing 80 pages, 6 in. by 9 in., with a great many illustrations. Cranes of all types are represented and detailed information is given concerning them.

Vise for Pneumatic Drills.—A four-page circular has been issued by the Independent Pneumatic Tool Company, Chicago, describing a new universal vise for pneumatic drills, the purpose of which is to firmly clamp and hold the drill in accessible positions while repairs, assembling and testing are done. Illustrations show the detail parts of the vise and how to use it.

Power Hammers. — A belt-driven and a motor-driven power hammer are described in a 16-page booklet published by Beaudry & Co., Inc., Boston, Mass. Both types are manufactured in various sizes and are described in detail, with tables showing sizes and dimensions. All the individual parts are illustrated and numbered for convenience when ordering.

Some Remarks from Dan McGann.—Under this title the Walworth Manufacturing Company, Boston, Mass., has issued a folder containing a short poem in which Dan McGann declares his adherence to the principles of Americanism in the vigorous language of the shop. The folder, which is suitable for use as a poster, has already had a wide circulation in industrial plants.

Constitution of the United States. — The Clark Equipment Company, Buchanan, Mich., has published an attractive booklet containing a reproduction of the Constitution of the United States and all amendments. It is illustrated with pen portraits of notable American Presidents by W. M. Young. This is a booklet which every American would be glad to have, and will be mailed on request.

Air Compressors.—Bulletin 75-U of the Sullivan Machinery Company, Chicago, describes in considerable detail the Sullivan tandem compound Corliss steam driven air compressors, class "WC", which are available in unit capacities of from 1,000 to 3,150 cu. ft. of free air a minute. Photographs accompanying the text show installations of the Sullivan Corliss compressors and indicate the range of service which they are performing.

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EDITORIALS

Notice

Notice is hereby given that the services of Clayton L. Smythe as circulation manager of this publication have been discontinued by us and that he does not now in any way represent the company or any of its publications.

Strictly a Business Proposition

THE June conventions at Atlantic City this year will surpass all records in every respect. Under the new form of organization and with the war excitement behind us, it has been possible to give much better attention to the preparation of the reports and to the rounding out of the program. The action of the Railroad Administration last year in encouraging a more general attendance of mechanical men met with cordial approval; moreover a large number of executive officers visited the meetings and looked over the big exhibit and were so greatly impressed that they indicated that they would encourage an even larger attendance this year. The exhibit space for the coming convention has been extended to include the balcony in the large main entrance hall on the pier and will cover almost 100,000 sq. ft. Even then a large number of concerns have had to be turned away because of lack of space.

Section VI, Purchases and Stores, of the American Railroad Association, will meet on the last three days of the mechanical convention, and this will not only add largely to the number of railway men in attendance, but in these three days and the preceding Saturday the exhibit will be crowded. As usual the Association of Railway Electrical Engineers will meet on Monday of the second week of the convention.

The expense of arranging for this big meeting and sending the delegates to Atlantic City will mount into hundreds of thousands of dollars. The *Railway Mechanical Engineer* believes that this expenditure is very much worth while, but it would like to take this opportunity of offering a few suggestions with a view to helping to get the greatest possible return from this great expenditure.

In the first place, what is such a convention for? Is it not primarily for intensive educational work coupled with the great inspiration which accompanies attendance at such meetings? This, if rightly directed, will result in more economical and efficient operation; if it does not show concrete results in this respect it will be extremely difficult to justify the continuation of the conventions on the present scale.

Who should go to the conventions? Every responsible mechanical department officer who can be spared from the job for part or all of the time, and particularly the ambitious, energetic young men who in a few years will be in line to fill more responsible positions. Many a young man has found himself at these meetings and has gone back to his job with an enlarged vision of the possibilities before him and a will to do. The railroads, particularly in these days, can ill afford to miss an opportunity of enlisting the enthusiastic support of young men of this kind. Any expense involved in their attendance at the Atlantic City conventions will be insignificant compared to the possible returns.

What should be the attitude of the delegates to the conventions? No railroad executive will authorize the investment of money unless it will bring a good return—at least 10 per cent—on the investment. The railroad man going to the conventions should realize that in order to make the trip worth while he will have to insure a good return on the cost of sending him to the meetings and paying his salary and expenses during that time. It is simply a cold-blooded business proposition and it adds an element of real sport to the occasion.

How can one get the greatest possible good from the convention? No one really attains any worth-while end unless he has a goal or definite objective constantly before him. It is not enough that a man go to the convention with good intentions and a disposition to profit by his attendance. He must go with the very definite object in his mind of trying to improve some troublesome condition or of increasing the efficient working of some part of the work in which he is interested. He may get help in solving his particular problem or problems in the convention hall; or it may be in interviewing men engaged in similar effort on other roads; or it may be in studying some of the exhibits, or in talking matters over with the engineers or service men of the railway supply companies; it may even be in conversations on the trains going to and from the convention. Too many men get into a rut and keep their noses so close to the grindstone that they miss big opportunities of profiting by the experiences of others. There are many striking examples on record of men who have been forcefully kicked out of the rut by mixing with their fellows at the conventions.

Frank McManamy took the bull by the horns last year and through the regional directors asked all of the mechanical men to report on the things which they heard or saw at the mechanical conventions which could be applied to advantage on their own roads. Mr. McManamy's idea was to encourage the men to use their time to the best possible advantage and therefore justify the Railroad Administration in arranging for a record-breaking convention. Unfortunately there was more or less misunderstanding as to the purpose of these reports. It is to be hoped that this year the heads of the mechanical departments will instruct their assistants as to just what features each individual should specialize upon, and then that the reports be made either at a staff meeting on the return home or to the head of the department in writing.

A written report need not be formal, nor need it be long or complicated. What is the thing you recommend? Why? Where should it be applied? What will its installation cost? What are its limitations?

These questions may refer to a device or a method or practice of some sort. Fifty words may cover your recommendations, but you must put them up in such a way as to sell the idea to your boss. Give the definite data which will help him to draw a conclusion; otherwise the matter may be laid aside and forgotten.

Just a word to the supplymen. Those exhibits which are most novel, or which are so arranged as to attract special attention to the special advantages of the particular device or equipment, will of course make the most distinct impression. Have your best service men and engineering talent on hand to talk to the man who is right from the firing line

and is anxious to talk practical details. If you do not know the men, don't judge too much by appearances. The big boss is not always the most prepossessing in appearance or the best dressed man in the group. Some supplymen will tell you this, to their great embarrassment.

The supplyman must remember also that mechanical officers are looking for real dollars and cents arguments as to the value of a device. It is to your interest to see that they get the right kind of concrete data to incorporate in their reports.

The Atlantic City conventions offer wonderful opportunities for big gains in the more efficient and economical administration of the mechanical department. What part will you have in securing better results?

An Inevitable Comparison

Many railroad mechanics and foremen are now contrasting their present condition with the situation in industrial shops. Industrial enterprises have generally been exceedingly prosperous in recent years and have found it possible to attract many experienced railroad men from the mechanical department. Under the circumstances it is inevitable that comparisons should be drawn at this time which are not always favorable to the railroad. The basis for this comparison is, however, not always a sound one. Industrial activity is now at its height and young men particularly are apt to overlook the possibility of a reversal in this state of affairs that will cause many of the less stable industrial shops to discontinue operations. Transportation has had its reversals, but it has always kept functioning and has tided the greater portion of its employees over years of severe business depression.

A further analysis of the situation will probably show that the policy of promotion on merit versus pull is, if anything, more generally observed by the railroads than industrial concerns. Except where industrials are organized on a very large scale the relation between ownership and operation is more intimate, from which it follows that promotion to executive positions is more often awarded to relatives and close personal friends of the owners than could possibly be the case on the railroads.

The operation of an industrial shop is generally more highly specialized than is the case with the typical railroad shop. This in itself appeals to many men, who prefer an even volume of routine work to the usual variety and emergency character of railroad work. The material situation is easily controlled in a factory manufacturing a single article and industrial shops generally appear to be in better running order than the average railroad shop, but is it to the advantage of the young man to be employed in a shop where every operation is planned for him and initiative is entirely in the hands of a production engineer? It might be advantageous for the railroad shop if a higher degree of scientific management prevailed, but it is doubtful if this would tend to develop the same energetic and resourceful men on whom the railroads are today so dependent.

There are other factors in this comparison between railroad and industrial shops that are less in favor of the railroads and with respect to which there is room for improvement. Industrial shops are generally housed in better structures, they are better lighted, better heated, better arranged and more sanitary than the average railroad shop. They are often located in the very center of a residential section that is admirably suited to the requirements of the employees, whereas railroad shops, if not located in some untenantable district adjoining railroad yards, are so far removed from any habitable center that the shop train must be resorted to in order to transport the employees to and from work. While location may be governed by conditions over which the railroads have little control, there is no corresponding reason why some of the community and welfare work promoted by industrial concerns cannot be undertaken by the railroads. To what extent are the railroads studying the personnel of their employees? How many mechanical executives have ever studied their labor turnover as compared with that of an adjoining railroad or a neighboring industry? The railroads are now in a position to do as much if not more for their employees, particularly the young men, as any industry, and this is a fact that must be made apparent to every one of their employees if the railroads expect to keep abreast of industrial development.

The Business Viewpoint

The extent to which mechanical executives can contribute towards making the operation of their railroads profitable depends entirely upon the extent to which they acquire the business viewpoint. Probably the best way to get this viewpoint is to consider how a new device, a new shop, or a new method would affect your pocketbook if you were the proprietor of the company. If you were convinced that a new device will save its cost in fuel and wages within a period of two or three years, would you not try very hard to make its operation a success? On the other hand, if it was determined that a new shop would cost one million dollars to build would you not want to be very sure that it would effect a real saving of at least one hundred thousand dollars per year before you would commit your company to this investment at the current rates of interest? How many mechanical men appreciate the fact that an increase in the material stock of a million dollars costs the railroad at least seventy thousand dollars a year? Possibly you would scan material requisitions more rigidly than the purchasing agent if your income depended on the company's annual surplus.

Have mechanical executives lived up to their opportunities; have they grasped the business viewpoint? Have the recommendations of the mechanical department always condemned unprofitable investments in mechanical equipment and fought for profitable expenditures, or has this question been left to the decision of a higher executive?

No official on the railroad has a greater opportunity to make the operation of his property profitable than the mechanical superintendent; no official has a better claim to executive rank; and, provided he acquires the business viewpoint, no official will advance more rapidly in authority over the operation of the railroad.

Stresses in Locomotive Running Gear

It is the general practice in designing locomotive running gear parts to allow a large factor of safety even with stresses based on safe values for carbon steel having low elastic limit and ultimate strength. The design of these parts is largely empirical; and while on large modern locomotives the parts are extremely heavy, due to the low stresses employed, very few roads have made any serious attempt to reduce the weight of rods and pins by the use of high grade materials. On account of the excessive weight of these parts many locomotives built in recent years are very difficult to maintain. While the boiler proportions are excellent and the operating results generally satisfactory, the design of the machinery from an engineering standpoint is a reproach to the mechanical officers.

The time has come to get out of the rut and to take a step forward. Alloy steels have been used on some roads with excellent results and more work should be done in developing their use, but the prejudice against the general use of a new material may retard the general introduction of alloy steels. There is no reason why higher stresses should not be used

in designing carbon steel parts, as it is possible to increase the strength of carbon steel forgings to a remarkable extent by proper working and heat treatment. A series of tests recently conducted on a forging seven inches square showed that by proper treatment the yield point could be raised from 45,000 lb. to 87,000 lb. per square inch. The resistance to impact showed a remarkable increase, the average energy required to fracture the bar when quenched and drawn at the proper temperature being more than seven times as great as that which caused fracture in the material as forged from the ingot.

The low elastic limit and ultimate strength in large forgings are no doubt due to the tendency to work the larger sizes at higher temperatures than the smaller sections. The direct result of this practice is to reduce the ability of the larger parts to withstand shock. The proper forging temperature of approximately 1,000 deg. C. or 1,830 deg. F. renders the material sufficiently plastic for thorough working by forging presses, though the power hammer is effective only in breaking up the crystallization near the surface.

A better appreciation of the effect of mechanical working on the properties of carbon steel would be secured if the impact tests were more generally used. Thorough working does not greatly alter the values obtained from tension tests, but impact tests show the remarkable increase in the ability to withstand shocks. The reduction of the dynamic augment is one of the most important questions now confronting the locomotive designer. The reduction in the weight of parts through improved design has probably been carried as far as is practicable. It is to be hoped that measures will be taken to lighten locomotive parts through the use of material which will withstand higher unit stresses.

Conventions and Committees

WITH several important conventions over and the June conventions at Atlantic City just ahead, it might be well to take account of some of the objects and a few of the results to be derived from any convention of railway mechanical men. The conventions must not only advance the knowledge of mechanical progress in transportation, but must broaden the outlook on all mechanical matters. The fact that a new method or a new device is making good on a single road should inspire mechanical men all over the country to ignore the immediate objections or the added complications and make this new method or device a success for the ultimate welfare of their own road. That a paper on train loading presented before a recent convention should be made the subject for discussion at a staff meeting of division officers is in itself proof that the good effect of conventions is far-reaching. No good paper on such matters as train loading, feedwater heating, improved shop methods or shop tools should become mere literature after the convention is over; it should be considered at the earliest possible staff meeting and continue to be a live topic on every railroad.

The task of writing the reports that go before these conventions should be taken very seriously by the committees to whom they are entrusted as they are a guide to individual practice on many roads. Every report represents an opportunity to effect an improvement in existing practice—sometimes a very great improvement—and the failure of a committee to put its best effort into a report or to cover the latest and most improved practice is an opportunity lost. There is need generally for a better working agreement between committee members and the chairman, so that the burden of preparing a report will be more evenly distributed and the report will more nearly represent the individual opinion of each member. It is suggested that this situation might be improved by permitting a chairman some part in selecting the other members of his committee.

Reports should be written so that they can be applied to specific problems, and will present the most advanced and dependable information on the subject to those who are seeking instruction. Committee members cannot know how much help their reports give to others, because they may have a far wider distribution than they suspect. But if the report is written to be used, it will be used. It may be discussed not only at staff meetings but at directors' meetings, and should be constructed accordingly.

Car Wheel Grinding

MACHINES for grinding the treads of car wheels have been used in the railway shops of this country about fifteen years, but in spite of this long test period which demonstrated their value, these machines have by no means come into general use. In fact one of the leading manufacturers, has made only eleven installations of car wheel grinding machines in steam railway shops in the United States. There are three possible explanations for this situation: (1) the possibilities in car wheel grinding are not realized; (2) the railroads are not in a financial position to purchase machines; or, (3) the practice is not as successful as some authorities claim. The last explanation is refuted by an article in the present issue which shows how long it takes to grind car wheels, what kind of wheels should be ground and the resultant saving effected. It is hoped that this article will convince many mechanical department men, hitherto sceptical on the subject.

Most of the car wheel grinding done in the past has been confined to chilled cast iron wheels with flat spots developed in the treads due to sliding. Provided a wheel is not otherwise defective experience has shown it is practicable to remove flat spots up to 3½ in. long by grinding. Owing to the fact that the depth of chill in a chilled cast iron wheel is limited, it is obvious that a longer flat spot can be ground out of a new than a worn wheel without going through the chill. The condition of the flange is also a limiting factor. According to the article referred to a substantial saving is effected by reclaiming chilled cast iron wheels by grinding.

All machine tools including car wheel grinders have increased in cost approximately 100 per cent in the past four years and it is plainly shown in the article that in order to pay heavy interest and depreciation charges the machine must be kept busy as much as possible. The maximum saving per pair of wheels is dependent on the ability to keep the machine in operation eight hours a day. Inasmuch as the average time of grinding a pair of cast iron wheels is 38 minutes, this requirement would mean that any railway shop receiving as many as 12 or 13 pair of slid flat wheels a day can well afford the installation of a grinding machine.

But the field for car wheel grinding is not limited to the reclamation of flat cast iron freight car wheels. Chilled cast iron wheels are now used to a considerable extent on light suburban passenger cars. While these wheels are cast approximately true in the foundry, there is always a possibility of the tread being slightly eccentric with regard to the journal, due to improper boring. Furthermore, the slight raised chill marks on the tread produce a whirring sound at high speeds and may cause increased wear on the rail. These are serious objections and have been overcome by grinding the new wheels before going into service. This insures a smooth riding car, without objectionable noises. In addition, a greater mileage is claimed for the ground wheel. The grinding of new chilled cast iron wheels has been extended also to wheels used on box cars, refrigerators, stock cars and caboose cars.

Car wheels with wrought steel tires are usually turned when the treads or flanges become worn and this practice is undoubtedly advisable and indeed necessary if the wheels are badly worn. For wheels that are only slightly worn,

however, a cut must be taken sufficiently deep to get under the hard surface skin on the tread. With a grinding machine, it is possible to true up this tread, taking off just enough metal to remove the imperfection and the grinding method in this case results in a considerable saving of surface metal. Experience shows that it pays to grind wrought steel tired wheels that are slightly worn, the limiting feature being the amount of flange wear.

With the cast steel car wheel, the arguments in favor of grinding stand out more prominently than ever and especially in the case of wheels with treads of hard alloy steel. These wheels can be reclaimed by grinding should flat spots develop, but they are first ground before being put in service. The time required to grind new wheels is, on the average, twenty minutes which includes ten minutes required to set a pair of wheels in the machine. At that rate, it would be possible to grind twenty-four pair of wheels in an eight-hour day.

In view of the manifest advantages of having smooth, round car wheel treads concentric with the journals, it would seem a paying proposition to install machines for grinding new car wheels and there is no important railway shop that could not keep the grinder busy either on new wheels or reclaiming old ones.

Breakage of Locomotive Cylinders

THE breakage of cylinders on locomotives is among the troubles which have increased with the introduction of large engines. The universal use of piston valves may be partly responsible for this trouble, or it may be due in part to the proportionately smaller clearance volume on large cylinders. The major share of the blame, however, may be ascribed to improper cylinder cock rigging. Little attention is paid to the maintenance of these parts; the long connecting pipes are often not properly supported, and if there is more than the usual amount of resistance to the movement of the lever the connecting rods buckle or the levers bend, with the result that the cylinder cocks do not open. The inevitable result is frequent breakage of valve and cylinder packing rings, if the cylinder itself is not fractured.

Several devices are now in use which operate the cylinder cocks either by compressed air or by the action of the pressure within the cylinder. It would seem that a more general application of such devices would be justified in cases where difficulty is experienced in applying a satisfactory design of manually operated cylinder cock rigging. It must be realized that such changes are open to objection on the basis that they introduce additional complication on the locomotive, but the cost of new cylinders or of welding broken cylinders, together with the loss of service from the locomotive, is so serious that there should be no question as to the desirability of using such devices where excessive cylinder breakage is experienced.

Adequate Reinforcing for Cars

SO many expensive mistakes have been made in building cars of light and unserviceable construction that it should not be necessary to call attention to the ultimate economy of substantial design, particularly in underframes. The new cars built at the present time are in most cases amply strong, yet some roads which insist that new cars should be of more than average strength are still applying underframe reinforcement that is entirely inadequate for present day service. Experience has demonstrated that where a steel center sill is added to a wooden underframe, the steel member takes practically the entire force of the buffing shocks. The wooden sills assist in carrying the load, but they offer little resistance to end thrust and have only a slight tendency to prevent buckling unless the construction is designed with special regard for this detail. Therefore, any steel center sill applied to wooden cars should have sufficient strength, when considered as a column, to withstand the shocks it will receive in service without depending upon the other parts of the underframe to help carry the end load.

The argument is sometimes advanced that a weak car is not worth reinforcing with a heavy center sill. A heavy center sill costs but little more than a light one and the cost of application will in most cases be practically the same. The slight additional investment is therefore a minor consideration, for the heavy steel member will take the shocks which would otherwise rack the body of the car and soon make it necessary to repair or rebuild it. The problem of underframe design has been discussed by the Committee on Car Construction of the Master Car Builders' Association and if its recommendations were applied also to the design of reinforcing, many costly errors would be avoided.

The Responsibility of the Unions

FOR several months practically every railroad in the United States has been working under the wage agreement negotiated by the Railroad Administration, which provides for a written notice of any desired changes in the wages or working conditions. During that time numerous "unauthorized" strikes have been called by local officers of the unions without giving notice to the railroads. The adjustment of wages is now in the hands of the Federal Wage Board and provision has been made for the orderly settlement of disputes, yet there are still numerous "walkouts," and in every case the responsibility for getting the men back to work comes back to the railroad officers. It is not an uncommon occurrence for a superintendent of motive power to waste several days each month trying to settle strikes at isolated points on the road.

The present wage agreement is a contract in which one party, the railroad, apparently assumes all the responsibilities while the other party, the labor federation, exacts as much as possible but promises nothing in return. The unions give no assurance that their members will return a fair day's work for a day's pay and when the contract is violated by a strike, disclaim responsibility by stating that it is unauthorized. If the railroad violates its agreement the union secures redress by striking; when the union violates the contract there is no redress for the railroad. Is it not time that this one-sided arrangement was changed? Should not the responsibility of the labor organizations be more clearly defined and some provision made for holding them to the fulfillment of the obligations of their contract?

NEW BOOKS

Steam Power. By Hirshfeld & Ulbricht. 420 pages, 7½ in. by 5 in. Bound in cloth. Published by John Wiley & Sons, Inc., New York.

This book may be described as a text book, a handbook and a thoroughly up to date treatise on steam power and power plant practice. The subject matter has been more fully dealt with in hand books and previous volumes on the same text, but in this book the attempt has been made to collect within a single volume such parts of the subject as would be needed by engineers whose work does not require an intimate knowledge of thermodynamic principles. The book, however, does give a very good conception of the subject of entropy and other theoretical aspects of steam power. The authors have made frequent use of charts in connection with the subject of fuel and combustion problems, and the descriptions of boilers and boiler appliances as well as steam engines, turbines and auxiliary apparatus is very complete.

This book was designed primarily as a text book, but will answer very well as a reference book for engineers interested in modern power plant practice and the operation of railway stationary power plants.

What Do You Think?

WHAT do you think is the most instructive, the most interesting or the most readable article in this issue? If you would tell the editor occasionally it would help make the *Railway Mechanical Engineer* a more valuable as well as a more readable paper. What editorial in this issue appeals to you most? If you know of a subject that ought to be brought home to the mechanical department, don't hesitate to suggest it for editorial comment.

This issue contains a description of a new up-to-date engine terminal that has replaced inadequate facilities and equalized the length of operating divisions on the Michigan Central. What do you think about the engine terminal situation? Are not larger and better equipped engine terminals more urgently needed than almost any other improvement on your railroad?

If your chief interest is in shop practice you will find numerous articles that should be of particular interest in this issue. The broader aspects of the machine tool situation are discussed on page 359. The methods used by the Canadian Pacific for locating weak points in the shop are described in the article on "Taking Up the Slack in Production." If you are having trouble with your tools you may find some helpful suggestions in the description of the Fort Wayne heat treating plant.

Stationary plants have been among the most neglected parts of railroad shops. The article by Mr. Rogers tells how capacity may be increased and fuel consumption lowered.

How much money could your road save by making small parts in quantities and sending them out over the system? It is an important question and one which the article entitled Automatic Machines an Aid to Production should help you to answer.

Are you availing yourself of the economies that can be effected by grinding car wheels? If not you should read carefully the description of that practice in this issue. The Shop Equipment section contains descriptions of many shop appliances and you may find there just the machine you are looking for. If you are interested in reducing shop costs it is suggested that you read Mr. Armstrong's plea for more thorough cost accounting.

Do you know that Germany has more locomotives now than before the war? No article contributed to the popular magazines or daily press gives you a better insight into the state of affairs in Germany than the article on the railroad situation in that country appearing in this issue. Railroad welfare is so intimately identified with national welfare that Mr. Thayer's account of these railroads may convince you that Germany is getting back on her feet.

Is it not interesting to note "feed water heat surface" listed along with other dimensions shown for the new German locomotives as though it were a factor to which we have always been accustomed? Don't you think that if feed water heaters are a success in Germany we ought to make a success of them in this country?

There seems to be a general impression that the Latin-American countries are behind the times, but you will probably reach a different conclusion after reading the article on South America by Mr. Risque. In this issue he tells of some interesting methods used to overcome difficult operating conditions in the Andes.

Even though you are not an air brake expert, you will want to study the report of the Air Brake convention. The paper on the steam consumption of locomotive auxiliaries is particularly important, as it shows a serious source of fuel waste that is often overlooked.

The author of the story "How the Master Mechanic Increased Production," has some unusual ideas about handling men which every foreman or executive should consider carefully.

In conclusion, don't neglect the comments on articles published in previous issues which are found on the next four pages. They represent the views of men who are right on the firing line and may give you a new viewpoint on some important questions.

COMMUNICATIONS

EDITORIAL ON SERVICE OF SUPPLY DRAWS FIRE

To the Editor:

I have a copy of the *Railway Mechanical Engineer* for May, 1920, and have read the editorial on page 256 entitled Service of Supply.

I do not think you have handled this on a broad enough basis; you admit that delays for material offer one of the best excuses for not getting power out, and later state that the supply department can usually produce a convincing argument as to savings made by reduction in material cost, which the shop superintendent cannot prove in dollars and cents. There is no room for argument as regards the desirability of having the very thing you need at your disposal at all times, but if this theory were to be put into practice, nine-tenths of our business institutions, as well as our railroads, would be in receivership. Such a proposition is not justified, except in case of war, and it is open to criticism even then.

Business must be conducted on the basis of its credit; if it spends more than its receipts and has not sufficient capital at its back to carry it through, it is insolvent. A railroad's operation must necessarily be based on its earnings, plus its borrowing power. Materials use approximately 35 per cent of a railroad's gross earnings; therefore, a railroad's expenditures must be guided largely by its earnings. Labor is fixed by law; the only savings that can be made in materials is its better utilization.

The problem of supply is one that embraces not only the demands, but is one of finance; every dollar tied up in material is unliquid capital and bears the regular interest rate, plus deterioration and obsolescence. Shop superintendents and shop foremen are interested only in their particular work and have no conception of the problem of supply, taking in, as it must, the entire requirements of the railroad.

A railway may need double tracking, passing tracks, yard facilities, round houses, shop extensions, shop tools, and many other things, but that is not given as an excuse for not moving trains, or even moving them economically. *The real measure of an organization or individual is what they are able to accomplish with the facilities at their command.* One may see locomotives and cars by the scores lying over for months for repairs, and at the same time hear the cry of work being delayed for material. There is no such thing as work on a railroad being delayed for material; there may be some particular work delayed for material, but there is always more work on a railroad than there is money or men to do, so that the losses experienced by lack of material are largely a myth on most of our railroads and in practically all of our shops.

Nothing in the above is to be construed as justifying the lack of sufficient material to protect the operations of the railroad; that is vital, but it can be set down as a fact, that the railroad that has the most material, has the least material available. The best operated railroads are the ones that have the least money tied up in materials, and an organization which is capable of meeting emergencies and utilizing everything they have to the best advantage.

General Purchasing Agent.

HANDHOLES VS. WASHOUT PLUGS

Great Falls, Mont.

To the Editor:

I have read with much interest the article by Mr. Lipetz on above subject in your April issue. If we adopted handholes on our locomotives, as used in Russia, they would be the source of much trouble and worry to our mechanical departments.

While Mr. Lipetz's argument in regard to safety might be true, yet accidents that happen in this country from washout plugs blowing out can usually be traced to carelessness on the part of the boiler washer, either in leaving a loose plug, or putting the plug in cross threaded.

I have just returned from Siberia after over two years' experience on the railroads there, and have seen considerable of the type of handholes described. The new American Decapods in that country are all equipped with these handholes; it is surely anything but ornamental to see the "horse shoe" clamps used on this device sticking out around side sheets and throat sheets. Boiler washers have to exercise great care in replacing the lead gaskets—have to feel inside to see that the seats are properly cleaned before replacing the cover, which process consumes much time.

I have also seen not a little trouble due to leakage, and when that happens in a country where bad water is practically unknown, what might happen in our bad water districts here where we get such an accumulation of scale and dirt. I am afraid the seats would be a continual source of trouble. Mechanical men are quite familiar with the troubles that our belly plate gaskets give and I don't believe they want more gaskets on the boiler. The initial expense of application is heavy compared to washout plugs, also the expense of continually renewing the gaskets.

It would be a step backward to replace washout plugs with handholes.

James Grant,
Great Northern Railway.

WOMAN IN RAILWAY SHOPS

Billerica, Mass.

To the Editor:

During the war, many women were employed in railway shops not only as clerks, sweepers and cleaners, but as machine operators in the tool rooms and machine departments. A long enough period has now elapsed to get a perspective of the results accomplished by this introduction of women into railway work and what the possibilities may be for the future. Most of the shop managements replaced their women employees with men as fast as the latter became available after the armistice was signed and men only are now employed. In some shops, however, women have been retained as sweepers and, in a few cases, operate machines such as lathes, shapers, milling machines, etc. The total number of women employees retained for shop work, however, is very small and it is doubtful if their number will ever be materially increased except in case of another emergency.

An analysis of the motives causing women to enter the railway shop service, shows why so small a number kept their positions after the war was over. In some cases, women took up the work to help support their families while the

men were in the military service. In other cases, the work was undertaken because a desire for notoriety and the opportunity to meet men. In still other cases, the principal motive was a liking for machinery and mechanical work.

Women who entered railway service for either of the two first motives could be classed as temporary employees and would remain only until they were married or the head of the family returned. The latter class, however, included a few women who became very efficient and skillful machine operators. They attended strictly to business, wasted no time and were more quick and dexterous than men in operating the lighter machines. These women were most welcome in any machine shop but, unfortunately, they formed such a small minority of the total number as to be practically negligible. On the road with which I am familiar only two out of several women employees developed into really skillful machine operators. FOREMAN.

SPECIFICATIONS FOR SOFT METAL BEARINGS

WASHINGTON, D. C.

TO THE EDITOR:

With reference to the article on soft metal bearings appearing in the May issue of the *Railway Mechanical Engineer* and your editorial on page 256 of the same issue. The first part of the article by Mr. Frank is an excellent presentation of the general principles of bearing metals.

The article next mentions the specifications of the American Society for Testing Materials. The committee which prepared them included railroad representation. The three bronzes specified are approximately similar to three of those specified by the American Railroad Association and the Railroad Administration. The assignment of two of these alloys to specific bearings is peculiarly different, however. The two last mentioned organizations use a harder metal for locomotive driving bearings than for car bearings, while the A.S.T.M. reverses this arrangement. From the standpoint of cool running (the most important feature of the operation of bearings) either alloy may ordinarily be used for either purpose. The driving bearings are, however, subjected to greater shocks, therefore from this standpoint should be of the harder metal. It is to be understood that the term is only relative. Both alloys are softer than the No. 1 bronze.

The reader of Mr. Frank's article may possibly gain a partially erroneous idea of the Railroad Administration specifications used for car and locomotive bearings during the war. They were not new ones. They were essentially the existing standards of the Master Car Builders' and Master Mechanics' Associations. The only changes made in the bronze were (1), a reduction in the minimum phosphorus in phosphor bronze for locomotives, from 0.7 to 0.4, on account of the scarcity of phosphorus, and (2) an increase in the maximum impurities in locomotive bronze to two per cent. (Before the U. S. R. A. specifications could be issued, a part of the locomotive hard bronze was ordered without phosphorus.)

The four U. S. R. A. bronzes were therefore as follows:

	Car Bearings	Locomotive Bearings: Phosphor Bronze	Medium Bronze	Soft Bronze
Copper, max	.....	82	77	65
Copper, min.	65	....	....	.....
Tin, min.	4	8	7	4
Lead	24 30	8-13	14 20	20-33
Phosphorus	....	0.4-1.0	0.2-0.6	.....
Impurities, max.	3	?	2	2

The car bearings were the largest item. Without stopping to make an accurate survey, it is safe to say that the average composition of the bearings actually furnished was much nearer 24 per cent lead, the minimum limit than 30 per cent, the maximum. The soft bronze was used only for hub liners and constituted only a small percentage of the total requirements for bearings. The composition, 65 copper, 5 tin, and 30 lead, can therefore hardly be called typical or average. The average lead would be much lower.

It is generally considered that the lead is the "anti-friction" constituent of the alloy and should be as high as possible, consistent with sufficient strength of the bearing and satisfactory foundry work.

It is agreed that temperature of pouring both bronze and lining metal is very important.

The writer does not agree that "little can be expected, at present, from inspection tests." Chemical composition within proper limits, with respect to both the essential constituents as well as the individual impurities, must be secured, and can be determined fully only by analysis. The other important detail in inspection is the surface appearance and the fineness and uniformity of grain and the soundness and homogeneity of the metal as shown by the fracture. In the hands of an experienced inspector these give much information on the conditions of manufacture. Microscopic examination is very useful in special investigations. Compression tests are not generally employed in routine inspections except for bearings carrying very high pressures.

H. E. SMITH,
Engineer of Tests, New York Central Lines, West (Asst. Manager Inspection and Test Section U. S. R. R. Administration).

I. A. LEARNS SOME THINGS ABOUT "PASSING THE BUCK"

TO THE EDITOR:

While at Westport, become necessary learn why dirty gage glasses not replaced. Hon. M.M. agree are not done because Stkpr. do not furnish. Sustain M.M. veracity, becomes bounden duty interview aforesaid Stkpr.

In pursuit of elusive person, Jap Detector at end directed clean cut young man in blue overall suit, and blue shirt with soft collar, who are bossing unloading gang. Sympathy are elicited by distressed appearance and learn he are helpless victim of Wage Board and U.S.R.R.A. "pass the buck."

Indicating Hon. self, he declaim that it are impossible eat, live and clothe on large salary Stkpr. U.S.R.R.A. have looked out for ash-pit shoveler, Bolsheviki, shop cobblers, all but Stkpr. Result he are responsible for keeping down R.R. H.C.L., but so busy making $1 buy $2 pork and beans, potatoes and other necessities keep body and soul, Hon. self and family, he are distraught.

G. F. who run back shop with help S. S. are laden with 275 iron men per month while Stkpr charged with $5,000,000 stock each year get 210 and storehouse foreman 115. Surprising intelligence are Hon. Stkpr in blue overalls. With majestic sweep of hand he declaim, other Stkpr's get $150, some $175.

Jap detector become further initiated in mysteries forbidden storehouse and find paper pins, also engine fireboxes in yard. Impressed by magnitude Stkpr job. Advised impossible keep man, when road contractor bid high, also industry in town, which account for fact he are overlook unloading when Jap Detector discover him.

Breast filled with pity for distressed Stkpr; hesitate. It are bounden duty as Imperial Government detector to learn why gage glasses not forth coming. Assume commanding attitude and demand explanation, beating down rising pity. Stkpr. tearfull admit such *are* true, but he are crushed struggling with H.C.L. and problem beans. Storehouse Foreman have succumbed to struggle with 115 iron men. Chief Clerk have gone digging ditches account need clothes to cover naked form. Load of Stkpr. so heavy impossible carry. Result no gage glasses ordered until G.F. and Hon. M.M. announce glasses assume zero. Some time G.F. announce twelve year boy can run Storehouse better Stkpr. Stkpr. reply he are d—m well cognisant truth stated, but G.F. job insignificant

alongside Stkpr. job, and he had two year boy make better G.F. than present incumbrance.

Stkpr. express great sorrow lack gage glasses and conclude "if Gage Glasses are so long come as promised wage boost, engine worn out when arrive." Ino Amsura.

THE SHOP WAGE AGREEMENT

New York.

To the Editor:

I am greatly interested in the invitation under "What Do You Think?" on page 191 of your April issue, to comment on Mr. McManamy's article in that issue on the Shop Agreement.

The shop committee idea was suggested by the Railroad Administration during the last few months of federal control and a number of the roads appointed such committees. Something might have been accomplished if the matter had been handled in the proper way. The difficulty lay in the manner in which the instructions were issued; i. e., to have the members selected by the regular shop committeemen. This, coupled to conditions that existed in the shops at the time, made the realizing of any good results very problematical.

Supplement No. 4 to General Order No. 27 was the first milestone and probably the worst one of the many things that were wished on us and which resulted in the tearing down of the structure of our organization. This placed all our mechanics—good, bad, and indifferent—on the same footing; prohibited rewarding merit in any manner; made our better mechanics dissatisfied in that they received the same wage as the incompetent workers; and in the cases of men who were working before as handymen and who were given full rated mechanics' pay under the application of this order, their status was in no wise improved—they were practically spoiled by receiving large sums as back pay.

Our former method of handling these handymen was surely much the best; they were advanced on the grade of work and in pay as they were worthy of advancement and in the course of time were promoted to full rated mechanics. This method gave the foreman an excellent opportunity to gain the workman's loyalty and co-operation,, as the foreman in all cases was required to recommend and approve those selected for promotion. In fact the application of Supplement No. 4 took away from the supervisors almost entirely having anything to say as to wage, making the situation most difficult.

In the Eastern district where the demand for skilled mechanics has been so urgent during the last three or four years and the railroad wage rates considerably under those paid on the outside, the foreman already had his hands full trying to prosecute work through the shops with a large per cent of poorly skilled help. Loading him up with an instrument embodying all the hide-bound union conditions found in Supplement No. 4 certainly could not improve conditions and went a long way to increase the already burdensome and inefficient conditions.

The next important move was the order that no mechanics could be employed after July 25, 1918, without having had four years' experience as a mechanic. Many of us were compelled during the war to employ men with less than this amount of experience; they were put on as step-rate men. The road had to be kept going; men of long experience could not be obtained. After considerable time had elapsed all these men employed after July 25, 1918, were advanced to the full rate and given large back pay sums. This made our older men in point of service very much dissatisfied and unsettled and materially helped along the growing undesirable conditions. While these men were either reduced to helpers or helper apprentices, under this order, the rest of the men felt that they were not entitled to the back pay, and took the attitude that they should not have been employed in spite of the fact that we were forced to do so during the war period, these very same men claiming that they were intensely patriotic and yet it was impossible to get them to speed up their production.

The shopmen utterly failed in selecting the best from among themselves as their union officers and committeemen; men with absolutely no judgment or balance were selected in many instances. In some cases they were men who could not intelligently read an order and properly construe it. In some instances they gave out wrong interpretations to the members which resulted in many complex situations and much dissatisfaction. Many men were wrongly influenced so that they developed a grudge against the company. It was a foregone conclusion that committeemen selected for the shop committee by the regular union committee would not be the kind of men that would make up a committee worth while—one that would assist the men in charge of the shops in bettering conditions.

As to the National Agreement; while it is possible that there were some benefits derived from this agreement in certain districts in that it made conditions uniform, results generally were not the best. There are many rules in this agreement that unquestionably helped along our already burdensome conditions. Absolutely no differential rates whatever were allowed to the men in the machinist craft. The blacksmith and boilermakers were given differential rates for practically all the men who do the better class of work; the machinists as a result were much disturbed. The old axiom of treating all men fair and square seemed to be farthest removed from the intentions of many of the orders that were issued.

The rule requiring two mechanics operating a long stroke hammer capable of driving 5/8-inch rivets or staybolts, or larger, was surely unnecessary. Two men cannot possibly work on a hammer driving staybolts. Also the rule requiring that sufficient help be furnished mechanics operating compound motors; our men tapping staybolt holes have for years done this work with a light one-man motor with no hardships whatever.

General Foreman.

INCREASED MILEAGE FROM ASSIGNED ENGINES

Taunton, Mass.

To the Editor:

The return of one of the heavy passenger locomotives to the repair shops of one of our eastern roads, after having handled one of the crack limited trains on that road for over a year between shopping and making a total of about 115,000 miles, when other locomotives of the same class cannot show an equal performance, gives rise to an interesting situation.

It seems, however, that this locomotive in question is handled by two engineers, on different days, of course, and the writer believes that this case and other citations to follow will go far to prove that the best way and the most economical way is to give a man an engine and let him keep it.

Another instance. On a certain eastern run of 57 miles, the death of the engineer caused a new man to be placed on this run. Several men and several locomotives were tried and finally a suitable locomotive was placed on this run, but the men had trouble handling the locomotive, and about every other trip a visit to the repair shops was necessary. About the first of March a certain careful engineer was placed on this run, and a man who was interested in his machine. The result has been that since that date this locomotive has not missed a trip, nor can one minute's delay be charged up to this locomotive. This engineer has this locomotive all the time and no other.

A certain north and south line in the Middle Atlantic

States has adopted this policy of assigning a locomotive to an engineer and with admirable results. I believe that one of our eastern trunk lines on its two most famous and fast trains uses this same policy.

Very well. If our railroad managers find it a wise policy to adopt this scheme for their fast runs, why not carry it a step farther and make it universal, at least for passenger trains. There no doubt would be too many difficulties to overcome in freight service.

Anyone who has overheard a group of enginemen talk after having completed their runs might well draw a conclusion that there was not a single locomotive on the road fit for service. Can you blame them? Any man who has to run about a half a dozen different locomotives in as many days is going to lose interest in his machine. What does he care if someone else is going to have her on the next trip? Give a man a rickety engine, and you will have a rickety engineer. Assign him a certain machine, let him study it, know the "kinks," what she will and what she won't do, and your runner will be making his schedules and saving money in the long end, and the average man, unless he is a hog, will take care of his machine—it is human nature to do so.

The old excuse will be that "It can't be done." It can be done if the managers are so minded. Another excuse—"the locomotive mileage will be reduced." Doubtless it will be *per month*, but how about it in the long run, say 12 or 18 months? Every time a locomotive goes into the shops for a thorough overhauling, it costs money, and the railroad is deprived of earning money from that locomotive every day it is in the shops, and this holds true when the locomotives undergo slight repairs, and in these days of high labor and material costs this item seems worthy of attention.

If a locomotive, assigned to one of our fast limited trains, in charge of two careful men, alternately, can produce 20 per cent more mileage between shopping, then figure out the proportionate reduction of shop charges and increase in train mileage, were every other locomotive of this class thus treated. Is it worth it? I think so!

CHAS. E. FISHER.

INFLATED TONNAGE RATINGS

CLEVELAND, Ohio.

TO THE EDITOR:

Mr. Mounce's article on practical freight train loading, which appeared in the May issue of the *Railway Mechanical Engineer*, is a very able presentation of the main problems involved in determining the tonnage that can be most expeditiously and economically handled. The article is in fact a very clear exposition of the principles involved and it would be difficult to take exception to the figures submitted by Mr. Mounce except from the standpoint of the practical means by which it is proposed to arrive at the desired results.

I have in mind particularly the effect which an inflated tonnage rating will have on the engine and train crews hauling these trains. It is well known that a great many locomotive engineers are governed in handling trains very largely by the tonnage which they are told that they are hauling. It is not always possible to explain to these men the significance of adjusted tonnage ratings and that a rating which takes into consideration a car factor added to every car in the train is to a certain extent fictitious.

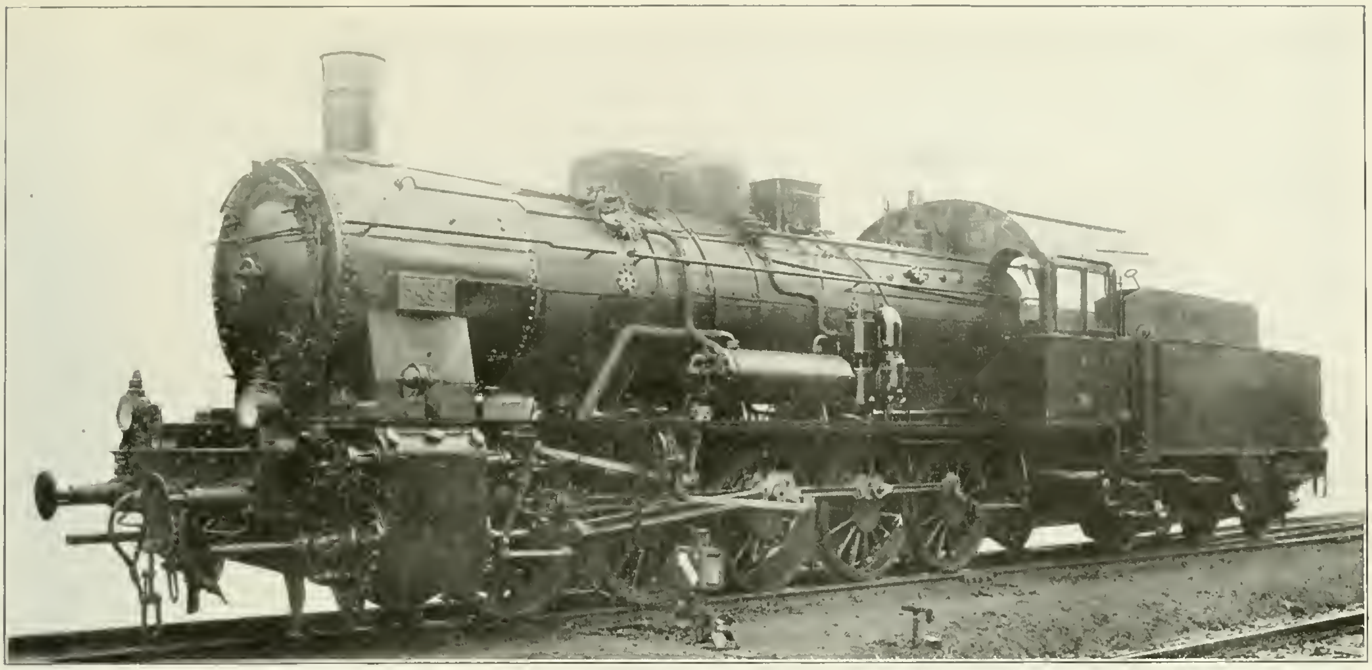
If a car factor is added to the weight of every car in the train in an attempt to equalize the variable resistance of cars of different weights, the result is an apparent tonnage always in excess of the actual tonnage. The result of this is that the apparent difference in tonnage between trains consisting entirely of heavily loaded cars and trains comprising only empty cars is exaggerated and we have what might be termed an inflated tonnage rating. This does not affect the scientific correctness with which the train is loaded, but it manifestly affects the psychological effect on the locomotive engineer who is hauling the train. This psychological effect may not be confined to the locomotive engineer, but may have an equally potent effect on the division superintendent who has not taken the pains to reason out the theory of adjusted ratings nor to carefully study their effect. The fact that the average tonnage per train handled over his division actually averaged considerably less than the average adjusted rating assigned to the division may have a very dampening effect on his enthusiasm for making a good tonnage showing.

We have to depend so much on paper or statistical showings to obtain results in modern railroading that it is well to respect any method that will sustain interest in making a good showing and discourage any procedure that tends to break down a favorable report even if the underlying motive is sound. Therefore, while it is highly important that all tonnage ratings be adjusted, it is equally important that any method employed, for securing these adjustments be such that the average car factor be as small as possible. The same ultimate loading, for instance, may be obtained by adding a certain car factor to every car in the train, dependent on its weight, as by adding a much smaller factor to some cars in the train and subtracting a factor from other cars. In the latter case it is obvious that the total adjusted rating of the train will be a much lower figure than in the first case, although the actual weight of the train will be the same. In fact, if the average weight of all freight cars to be handled were approximately the same and this weight were known, the adjusted rating could be made to equal the actual rating, or if this were a permanent condition there would be no necessity for adjusted ratings.

The point is that in determining adjusted ratings for any freight division, an attempt should be made to determine the approximate average weight of cars usually handled over the division in each direction. This weight then should be adopted as, what might be termed, the neutral weight and all car factors to be employed in the adjusted rating should be based on this weight. To all cars below this so-called neutral weight a car factor should be added, increasing in amount as the weight of the car diminished; while from all cars exceeding this neutral weight a proportionate car factor should be subtracted. Unless there is great variation in average weights of cars handled in a single direction over a certain division the adjusted rating can be determined in the manner above outlined, so that the adjusted rating assigned to freight trains will not vary greatly from the actual weight of these trains. The actual weight of trains and the total tonnage hauled over a division will theoretically be no greater with adjusted ratings corrected so as to approximate actual tonnage than with adjusted ratings computed in the manner outlined by Mr. Mounce, but the practical results obtained from a tonnage standpoint will be much improved, due to the fact that there is a much better understanding among all concerned in the movement of trains as to the actual tonnage handled by each train.

Under the arrangement outlined by Mr. Mounce it may happen that the adjusted tonnage where principally empty cars are being handled is 500 tons in excess of the actual tonnage. If this adjusted tonnage were corrected on the basis of the average weight of cars handled, which in this case would take into consideration the preponderance of empty cars moved, it would probably not vary more than one hundred tons from the actual tonnage. Practical men know the great value of having a system that does not confuse those to whom its execution is entrusted. The adjusted tonnage rating should conform to this rule and while retaining all the advantages to be secured from the equalization of car resistances must be exceedingly simple in its application and should not involve results which are not clearly understood by all concerned in its application.

L. GREENLEAF.



Superheater Freight Locomotives of the G-10 Type for the Prussian-Hessian Railway. The First Locomotive Built by Krupps.

THE RAILWAY SITUATION IN GERMANY

Shortage of Locomotives the Limiting Factor. Output of Labor Greatly Decreased

BY ROBERT E. THAYER
European Editor of the Railway Mechanical Engineer

THE aftermath of the war in Germany has been much more severe than perhaps was anticipated at the end of the war. The new government, formed after the revolution, was made up of men of little experience in the governing of a nation the size of Germany and as a result there has been a constant state of unrest, dissatisfaction and no co-ordination of effort. With the bolshevistic seed fairly well germinated, it was doubly hard to get the nation back on a peace time rating. It has been the labor situation that has delayed the recuperation of this country. Not only has this been felt in the industries but on the railways.

Part of a Mixed Train on German Railway

Whereas before and during the war and up to the year 1917, the German railways earned sufficient revenue to pay a dividend to the state, the cost of materials and wages increased to such an extent in 1918 that there was a deficit of 3,800,000,000 marks, and in 1919, this rose to 4,600,000,000 marks. For 1920, it is anticipated that the figures will be considerably higher than this, for during that year some 2,000,000,000 marks were added to the railway pay roll. In order to meet this added expenditure, the rates up to the present time have been increased 600 per cent for freight and 700 per cent for passengers as compared with the pre-war rates.

Serious Lack of Available Power

One of the greatest difficulties the German roads are experiencing today, is the lack of adequate locomotives. Notwithstanding the fact that Germany has a greater number of locomotives now than it had at the beginning of the war, it has been unable to keep them in repair on account of the extremely poor labor conditions. The low morale of the shop forces is almost unbelievable. It has been authoritatively stated that the output has decreased to from between 20 to 30 per cent of the pre-war output and at the same time wages have been increased from four to five times. Conditions were so bad during the early part of this winter, that it was found necessary to close some of the shops absolutely for a few weeks in order to teach the men a lesson. These shops were then reopened, each man being employed being required to work under conditions laid down by the railway shop managers. In some instances it was found that the men in the pattern shops were spending their time making toys which they sold later on the streets.

At the same time, due to the Peace Treaty, the German roads have lost 12 or about 16 per cent of their main repair shops and 3, or 23 per cent of their secondary repair shops. The conditions were so bad that in order to maintain any semblance of railway service repairs had to be put out on

contract to various industries that were in a position to handle such work. The equipment builders were requisitioned to take on repair work. Krupp's plant has repaired some 500 locomotives and has between 100 and 200 on hand for repair. The shipbuilders principally took on this work as the construction of ships has practically been brought to a standstill. The North German Lloyd is making a specialty of repairing cars and has handled some locomotive repairs.

Condition of Passenger Cars

The passenger equipment which is in operation may be said to be in good running condition, but its finish and upkeep is deplorable. The cars are dirty inside and out, there is practically no covering on any of the seats and the passengers have to be content to ride on cushions of dirty buckram which has become shiny with use. Many of the windows, which are of the drop sash type commonly used on the Continental roads, are in an inoperative condition due to the fact that the leather straps by which they are operated have been removed. This condition has been caused by the fact

Crowded Fourth Class Cars in Germany

that the seat coverings and the leather straps were cut away by passengers riding in the cars or thieves in the car yards, as there was a serious shortage of all leather and cloth goods.

Increase in Number of Locomotives Owned

While it is impossible to obtain detailed figures regarding the condition of locomotives for all of the German railways, the condition on the Prussian-Hessian system may be taken

Locomotives on the Prussian Hessian System

Date	Locomotives owned	Percentage in bad order
1910	19,670	...
1911	20,187	...
1912	20,758	...
Aug. 1, 1914	21,882	19.5
Nov. 1, 1918	27,991	33.5
Mar. 30, 1919	22,538*	43.2
Sept. 3, 1919	23,248	44.6
Jan. 15, 1920	23,956	47.2
Feb. 12, 1920	23,224**	46.2

*After locomotives were delivered to the Allies.
**After locomotives were delivered to Poland.
Note Germany has still to deliver to the Allies under the terms of the armistice, 286 locomotives and 2,000 cars. The Prussian railways now have on order some 1,500 locomotives.

as indicative of the entire country. This system owns about 81 per cent of all the locomotives in Germany and on January 15 of this year over 47 per cent of its locomotives were out of service for repairs. In view of the further disturbances that have risen in Germany, this figure has probably increased to over 50 per cent at the present time. Table I will show for the Prussian-Hessian system how the percentage of locomotives in bad order has increased.

This table also shows the increase in the number of locomotives on the Prussian-Hessian system from 1910 to February 12, of this year. It will be seen that before the armistice was signed (November 1, 1918) the Prussian system

Engine Storage Shed at Dusseldorf

had 27,991 locomotives as compared with 21,882 at the beginning of the war—an increase of 6,109. For all the roads in Germany the increase in locomotives owned was 6,648 (about 24 per cent) or a total of 34,570 on November 1, 1918. Of the locomotives turned over to the Allies under the terms of the armistice the Prussian system furnished about 83 per cent and this accounts for the drop between

Locomotive Equipped With Feedwater Heater

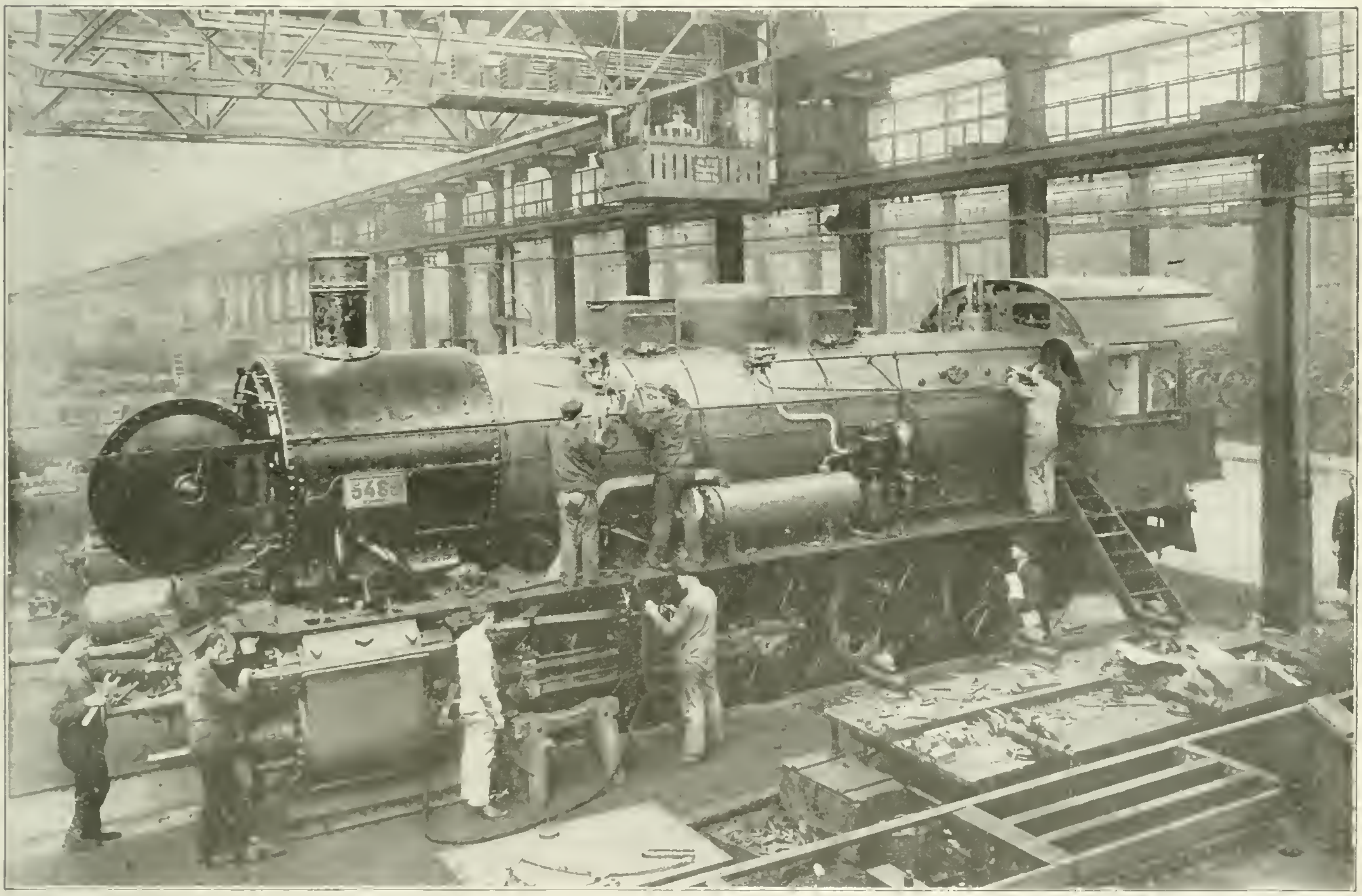
November 1, 1918, and March 30, 1919. There is a further drop between January 15 and February 12 of this year, of some 734 locomotives which is accounted for by the fact that at that time Germany was required to turn over a large number of locomotives to Poland.

The fact that Germany has more locomotives today than

she had before the war, regardless of the fact that she had already turned over 5,000 locomotives to the Allies, is accounted for by the intense locomotive production during the war. The locomotive manufacturing plants were called upon to do nothing else but build locomotives. Each plant was given a specific design to build and they turned them out in large numbers. It has been stated that during the war the number of locomotives built for the Prussian-Hessian system since 1913 averaged from 1,200 to 1,500 per year. Practically all of these locomotives were of a heavy type—for Germany—and of the most improved design.

New German Locomotives

Two of the latest designs built for the Prussian State are of the 2-8-0 and the 2-10-0 types, their principal dimensions being shown in the accompanying table. Both of these engines have three cylinders. The inside cylinder is inclined and all three drive on the third axle. The right-hand driving crank follows the left at an angle of 120 deg. and the inside driving crank forms an angle of 152 deg. 21 min. with the right-hand outside crank and an angle of 107 deg. 39 min. with the left. These engines are equipped with the Schmidt superheater, brick arches and feed-water heaters. From trial performances it is found that the 2-8-0 locomotives were capable of hauling, on the level, 1,150 long tons at a speed of 40 m.p.h. while the 2-10-0 type was able to handle 1,400 long tons at the same speed. It is interesting to note that these engines are not compound and as a matter of fact with the present degree of refinement in superheating and feed-water heating, the engineers of the Prussian-Hessian have given up the idea of building any more compound locomotives.



Erecting Shop at Krupps

Principal Dimensions of New German Locomotives

	2-8-0 Type	2-10-0 type
Service	Freight	Freight
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Weight in working order	179,000 lb.	205,000 lb.
Weight on drivers	150,000 lb.	176,000 lb.
Weight per axle	37,500 lb.	35,200 lb.
Wheel base, driving	14 ft. 9 in.	19 ft. 8 in.
Total wheel base	23 ft.	27 ft. 11 in.
Cylinders, number	Three	Three
Cylinders, diameter and stroke	20½ in. x 26 in	22½ in x 26 in.
Valves	Piston	Piston
Drivers, diameters	55 in	55 in.
Boiler	Belpaire	Belpaire
Working pressure	206 lb.	206 lb.
Tubes, number and diameter	189, 1¾ in.	189, 1¾ in.
Flues, number and diameter	34, 5 in.	34, 5 in.
Length of flues	13 ft. 5 in.	15 ft. 9 in
Heating surface, tubes and flues	1,662 sq. ft.	1,947 sq. ft.
Heating surface, firebox	135 sq. ft.	153 sq. ft.
Heating surface, total	1,797 sq. ft.	2,100 sq. ft
Superheating surface	629 sq. ft.	736 sq. ft.
Feed water heater surface	146 sq. ft.	146 sq. ft.
Grate area	37 sq. ft.	42 sq. ft.

Modernizing Railway Equipment

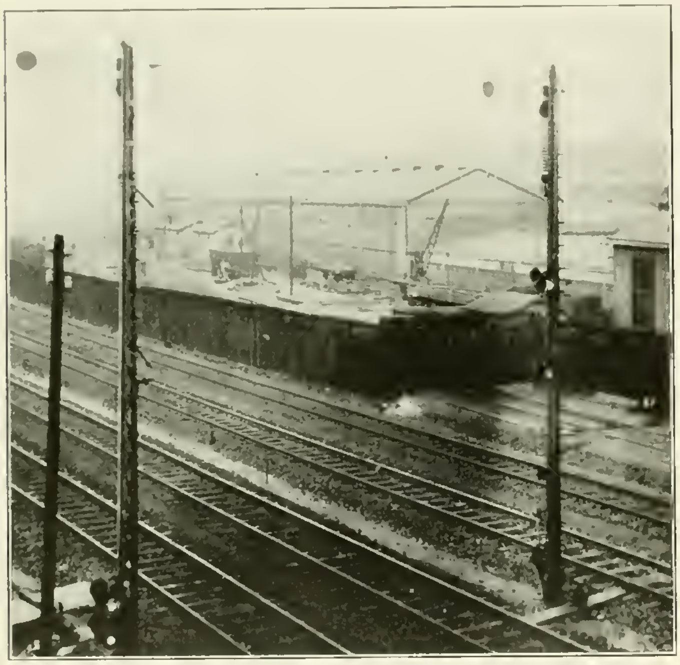
The coal situation in Germany has been disastrous to the railways as it has been to all of the other industries. It has always been the desire of the German railways to keep a three months' supply of coal in storage but at the present time it is difficult to get a supply for more than three or four days. Whereas in December, 1913, the Prussian-Hessian system held an average of 3,000,000 tons on hand, in February, 1920, the supply was only 100,000 tons which was hardly sufficient to last three days. In addition to the lack of it, coal has been of a very inferior quality and whereas the standard consumption was about 15 tons per 1,000 locomotive-kilometers it is now between 20 and 25 tons. Due to the severe shortage of lubricating oils, it has been necessary to extract the coal tar products of the coal which has thrown a large amount of coke on the railways for locomotive use.

Large Numbers of Feed Water Heaters Applied.—As in everything else, the price of coal has greatly increased. Be-

fore the war it was purchased for 12.5 marks per ton, but the railroads now have to pay 200 marks per ton. It will thus be seen that the increased cost of fuel has been a great factor in the increased operating costs. In view of this situation every attempt has been made to increase the efficiency of the locomotives. One means of doing this is by the application of feedwater heaters to all new locomotives with a plan in progress of applying them to all existing locomotives regardless of type or service. The success the German railways have had with the use of feedwater heaters has warranted this development. Whereas the thermal efficiency obtained is between 10 and 12 per cent there is a claim for an overall economy from 20 to 25 per cent.

This feedwater heater is known as the Knorr heater. It is of the tubular type taking exhaust steam from the cylinders and auxiliaries. The feedwater is forced through it by a pump located between the heater and the tank, which thus keeps the heater under boiler pressure. It has been estimated that these heaters will more than pay for themselves in the economy they produce under the present price of fuel within one year.

Freight Cars to be Equipped With Compressed Air Brakes.—As indicated by the manner in which the German railways



Railway Entrance to Krupps Plant at Essen

are applying feedwater heaters to their locomotives, the officers are not hesitating to spend money in order to save money regardless of the fact that the roads are now being operated under such heavy deficits. In addition to improving the locomotives a very extensive program is being carried out in equipping the freight cars with Kunse-Knorr automatic air brakes. This is a compressed air brake which is standard on the Prussian system. A program involving the expenditure of 260,000,000 marks for this purpose has been started. One-third of the existing cars on the Prussian system, or about 175,000 cars, have been equipped with this brake and all new cars will be. By 1927 it is planned to have all freight cars on the Prussian system equipped. It has been estimated that at the end of 10 years a saving of 60,000,000 marks will be obtained, after having paid for the cost of the installation, as a result of the saving in wages of the train crews alone. This brake is of a relatively new design and operates on a principle similar to the Westinghouse brake.

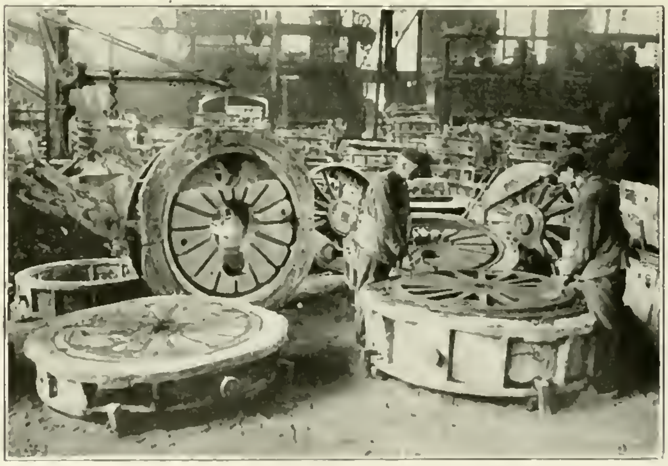
The Continental roads before the war endeavored to come to some arrangement for the application of a standard brake to all freight cars in order to facilitate the interchange of traffic. The problem at that time was whether the vacuum or compressed air brake should be used. Strangely enough the strongest advocates of the vacuum brake were to be found in Austria and even during the war, tests and negotiations were carried on between Austrian and the German roads in an attempt to settle the matter between them, but the unsatisfactory closing of the war to those countries prevented an agreement being reached. It appears by this extensive ap-

Passenger Car on Turntable Lead in the Station at Dusseldorf

plication of the power brakes to the Prussian roads, an attempt is being made to force the compressed air brake on all other nations in central Europe if they want to participate in the exchange of equipment with the German lines. While the use of automatic couplers is greatly desired to replace the screw couplings on freight cars, plans have not been developed sufficiently to permit of any definite action in this respect.

Car and Locomotive Building by Krupps

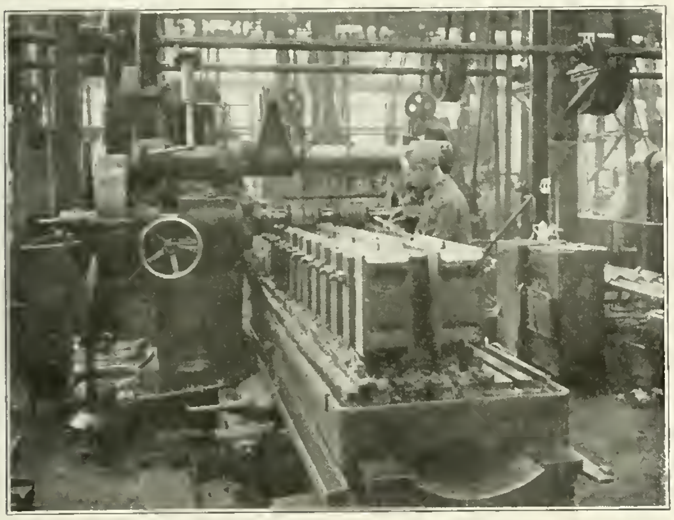
During the war the munition plants in Germany were developed and extended to a great degree and on the return to peace conditions these plants have been seeking to reconstruct and adapt their facilities to peace-time pursuits. The



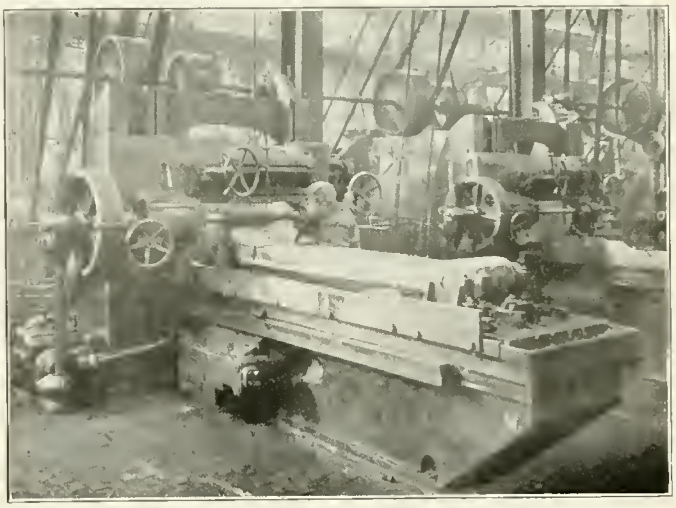
Wheel Foundry at Krupps

greatest of these concerns is Krupps at Essen, and among other things, this company is planning to go into the construction of railway materials on a large scale. Whereas before the war 50 per cent of its income was derived from war materials, at the present time the demand for them is practically eliminated and the only war material Krupps intends to make will be to meet the requirements of Ger-

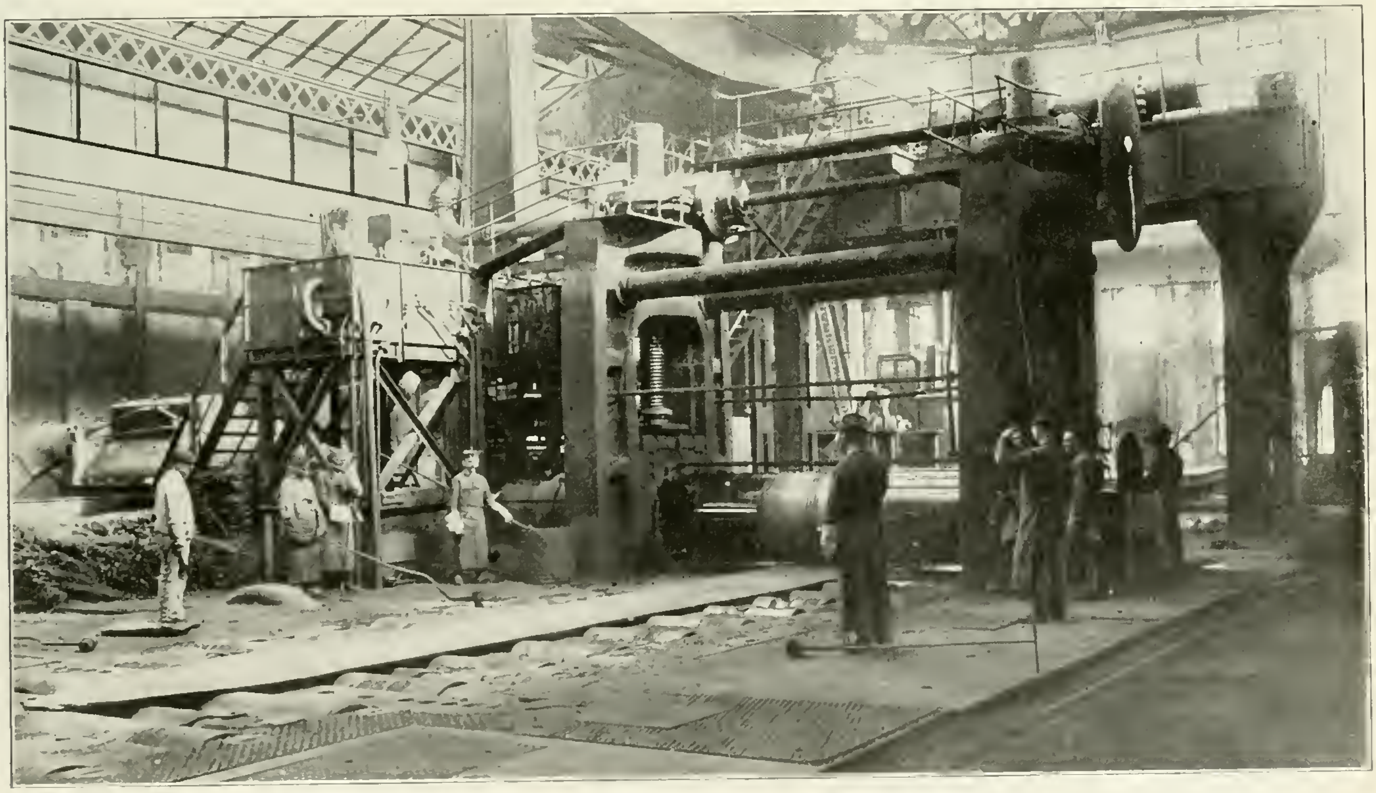
many's small army and navy. It is the intention of this company ultimately to be in a position to provide everything in the iron and steel line which goes to make up the construction of a railway. Before the war this company constructed a large amount of railway material, among which may be mentioned forged wheels and axles and springs of all types. During the war it increased its wheel and axle capacity by 100 per cent and at the present time it is building locomotives and cars at the rate of 300 and 2,000 per year, respectively, working two shifts a day. Plans have been made to increase this capacity to 900 locomotives and 20,000 cars as the occasion demands.



Milling Driving Boxes at Krupps



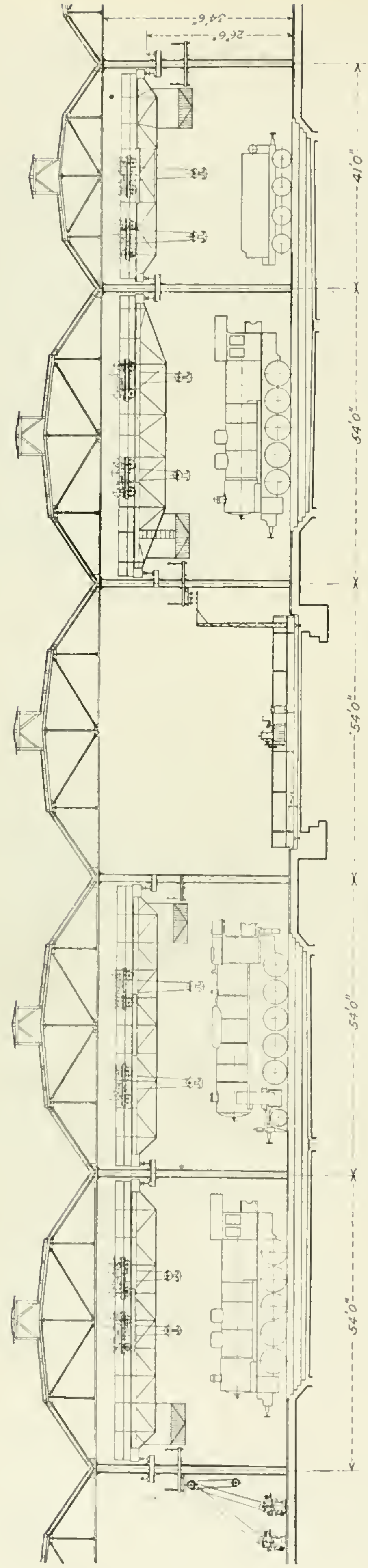
Milling Rod at Krupps New Locomotive Works



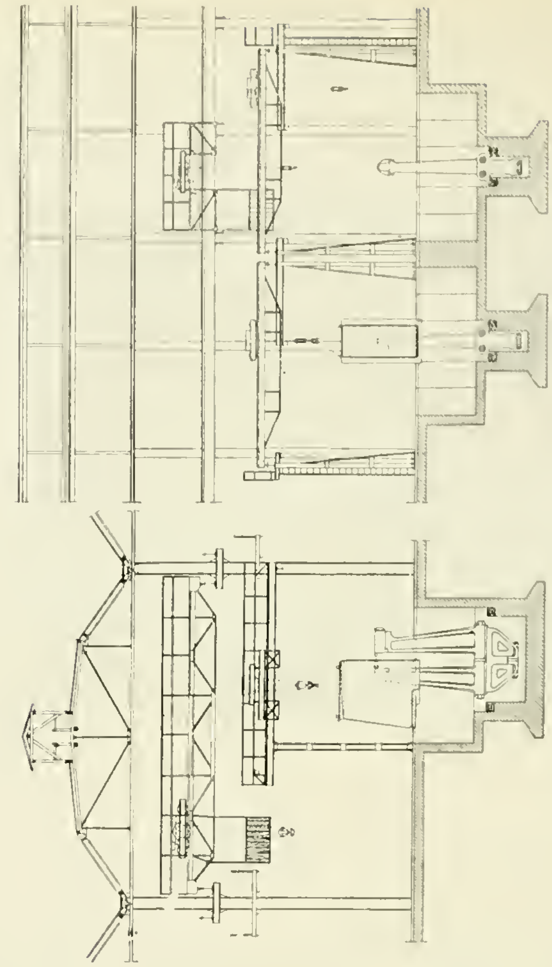
Armor Plate Mill for Rolling Plate and Locomotive Frames

The plant used for the manufacture of cars and locomotives is a new shop which was erected for the construction of guns and gun carriages and occupies a space of over 18 acres. These shops are particularly well located for the construction of railway equipment as they are adjacent to the main line of the railway through Essen, which has several sidings leading into the plant. The plant itself is well equipped with cranes and much of the machinery used for the munition work can be used to good advantage for the present work. The accompanying diagram shows an outline of the shop and the manner in which the material is routed through it. It contains 19 bays of medium size running parallel with one another, all being equipped with electric driven cranes. It has been possible thus to bring under one roof all the necessary operations in the construction of cars and locomotives with the exception of die making, forgings, castings, axles and wheels, which are made in other shops of Krupps plant.

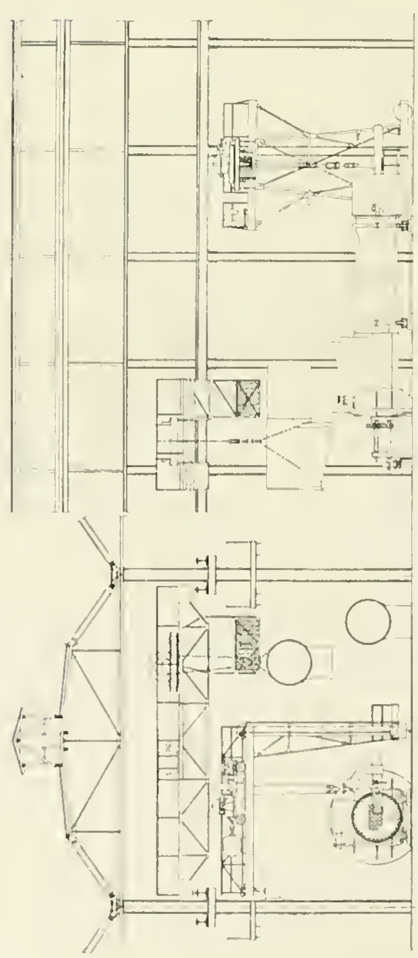
By referring to the diagram of the shop it will be seen that all materials for the construction of boilers, cranes and



Section Through the Five Bays in the Erecting Shop

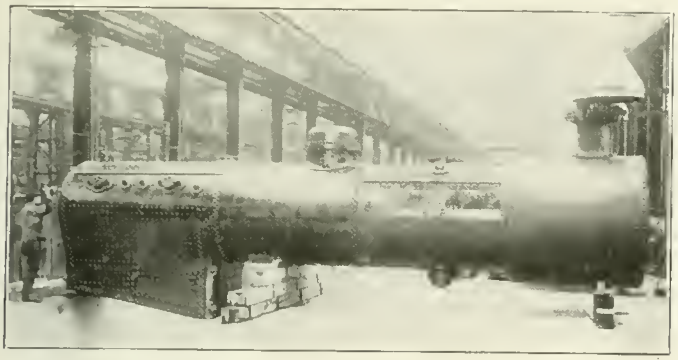


Section Through Boiler Shop Showing Hydraulic Riveters



Riveting the Boiler Barrel

tenders, with the exception of such parts as are made in the shop itself, enter the shop by a lead from the railway at the southern or right hand side of the building. After passing



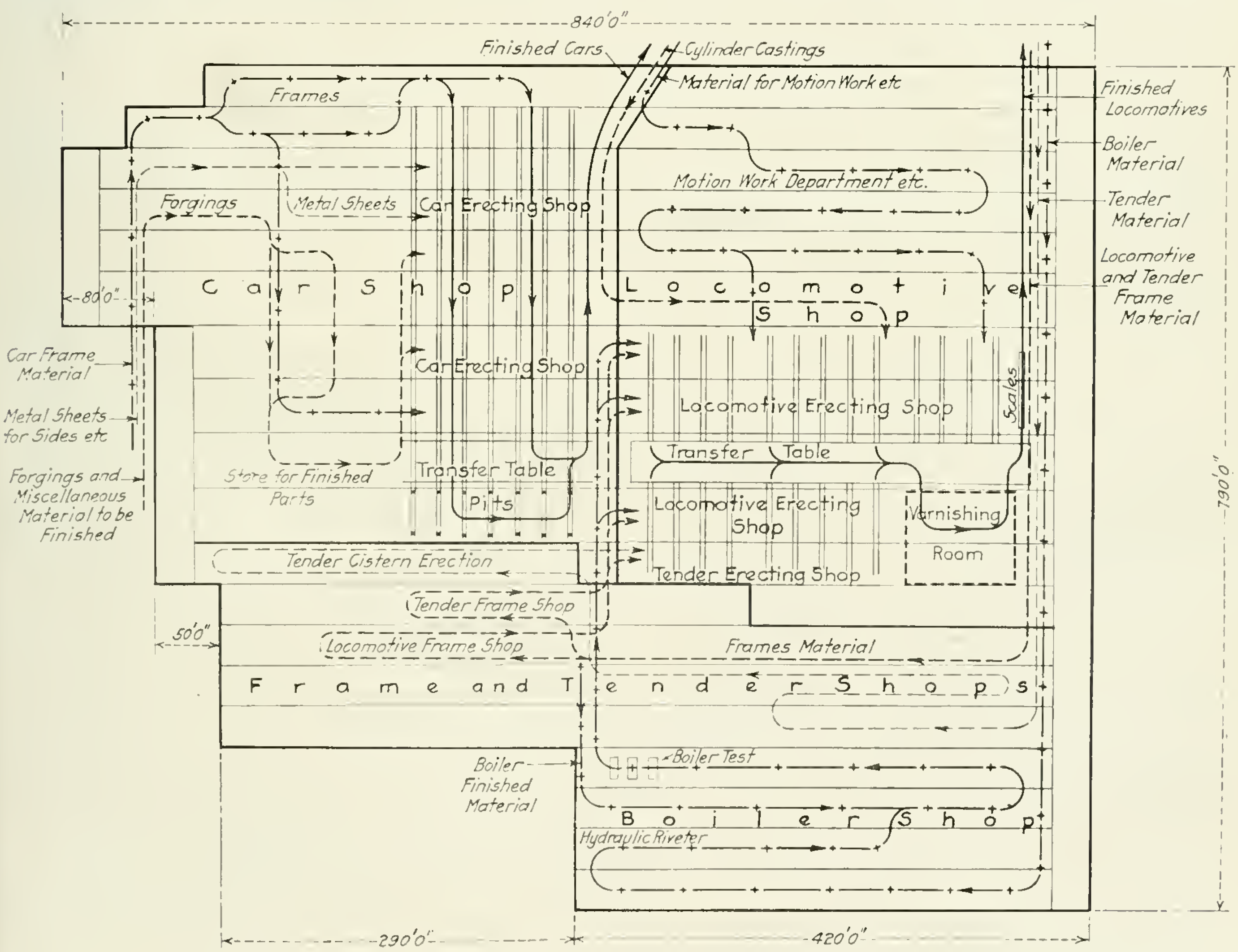
Testing Locomotive Boilers at Krupps

through the respective bays as indicated in the diagram, the boilers and frames are delivered to the erecting shop by way of a middle standard gage track which also communicates off the pits onto a transfer table and are delivered to the varnishing department where they are varnished and from there pass out over the locomotive scales to the railway by way of the southern railway siding.

The material for the car building section of the plant is delivered over the railway lead on the south or left hand side of the plant. The various finishing work is done in the bays indicated and follows on in a progressive direction to the longitudinal erecting shop and from there by means of another transfer table to the middle track and out of the shop onto the railway.

These shops are well equipped and have every convenience with the exception of a crane heavy enough to lift a finished locomotive and for this purpose electric jacks are used. The erecting pits are equipped with special gage plates not only for the standard gage but also for larger gages—for instance such as are used in Russia and Spain. Each of the manufacturing sections has its own tool department in order that the special tools required in the respective departments will be properly maintained.

Soon after the armistice the work of converting this plant was done and the work on the locomotives was started in



Plan of Krupps Locomotive and Car Shop and Routing of Work

with the main line railway. Likewise the routing of tender frames and cisterns can be followed.

The cylinders and material for the driving gear are delivered to the shops by the middle track and after passing through various departments for finishing are delivered directly to the erecting shop. The finished locomotives come out March, 1919; the first locomotives and cars being turned out in December, 1919.

Export Situation in Germany

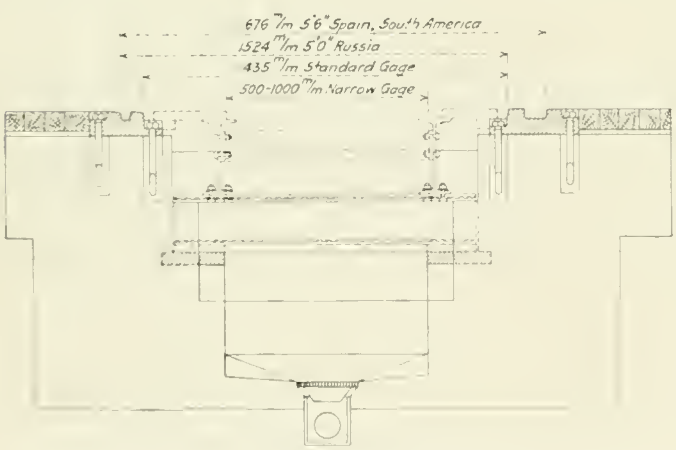
Shortly after the signing of the armistice great apprehensions were current lest Germany, in view of the low rate of

exchange which came into effect the early part of last year, should follow a policy of dumping its products on the foreign markets. To a certain extent this was done but it did not last for long on account of the lack of materials. There was a lack of sufficient labor and there was a demand for a certain amount of reconstruction within its own borders. There was a time, however, during last year when machine tools came into Holland so fast that they could not be handled. The situation grew so bad that it was not uncommon to have these exports lying in the open field uncovered and unprotected from the weather. They were sold on the ground for what they would bring.

What will be done in the future in the matter of exports depends upon the raw materials that can be obtained, and in this respect Germany is in a bad way. It suffers for the lack of coal; it must import most of its iron ore; its steel production has been greatly diminished and the labor situation has been most difficult. In addition to this the cost of labor and materials has, to the Germans, increased to an alarming extent.

In the year 1913, Germany produced about 175,000,000 tons of coal. Under the Peace Treaty it has lost about 35 per cent of its coal producing area and in addition it must deliver from 31,000,000 to 39,000,000 tons of coal to the Allies. The coal miners in Germany have the 7-hour day and the output per man has materially decreased and with it the quality of the coal.

Likewise Germany has lost 72 per cent of her ore fields and a large proportion of her pig iron and steel manufacturing facilities. The production of pig iron decreased from 19,309,000 metric tons in 1913 to 6,292,537 metric tons in 1919. Likewise the steel ingot production decreased in the ratio of 18,935,000 to 7,768,569. While the theoretical capacity of steel production under the present German boundaries is from 12,000,000 to 14,000,000 tons per year, Germany has only been obtaining a production of from 7,000,000 to 8,000,000 tons on account of the shortage of coal, iron ore



Cross Section of Erecting Pit in Krupps Shop Showing Arrangement for Varying Track Gauge

and the general labor conditions. As a general rule it may be stated that the cost of labor in Germany has increased from 500 to 700 per cent.

The cost of materials has risen very greatly. Basic pig iron prices have increased from about 60 marks per ton at the beginning of 1914, to 2,227 marks on March 1, 1920. Billets have increased from 100 marks to 2,290 marks. Plates have increased from 103 marks in January 1914, to 3,435 marks at the present time. Prices of ordinary steel has increased in like proportions.

These figures and the general condition of Germany today do not indicate that she will be in a position to do any very heavy export business but it must be remembered that the facilities for doing a vast amount of work still remains in Germany and as conditions become settled there will be a great demand for the use of these facilities. Germany is looking particularly to the Russian market. It is well known that the condition of railway equipment there is very bad and when a dependable government has been formed in Russia there will be great opportunities for big business.

It has been the policy of German industries in foreign trade to consolidate and there is at the present time an association known as the Verband Deutscher Wagonfabriken which is similar to the Railway Car Manufacturers Association in the United States, but with far greater powers

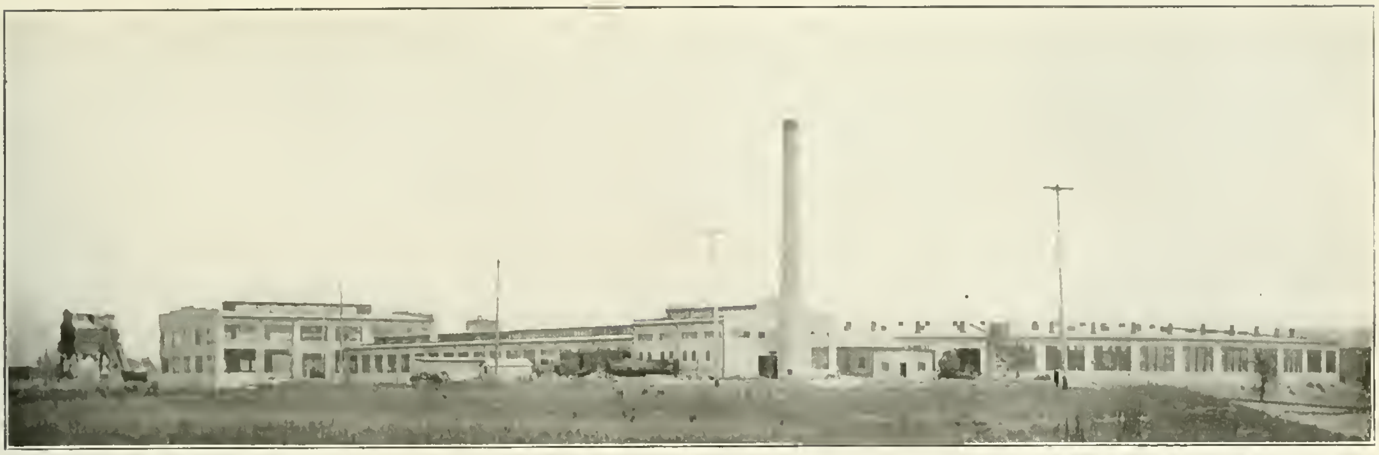
Typical Box Cars for German Railways

and more executive authority. This association has its head offices in Berlin and controls the prices of cars of all its members. Without doubt as Germany begins to find herself there will be more of these associations formed for the handling of export business.

A Hot Box.—In connection with recent earthquakes in Mexico a darky preacher down in Texas is said to have evolved a remarkable theory, which seems to fit in very well with certain existing circumstances. He promulgates his theory of the earthquakes as follows:

"We has received anudder warnin' not to go pesticatin' into de ways ob Providence. De earf, my breddren, revolutes on its axels, as we do now all know, and we all know dar mus' be sumefin to grease dem axels and it takes a right sma't ob grease to do it. So de good Lord done put de 'troleum inside de earf to keep de axels greased. Den byme bye 'long come all dese hyah oil companies, punchin' holes down into the bearin's and de oil all come squirten' out. Fust thing we know dar's a hot box, and de earf squeaks and jolts and rumbles and dat's de earfquake, and if dey don't quit pretty soon dere won't be no moah grease left and the earth will stick tight on its axels and won't go round no moah!"—*C. W. Savery Market Letter.*

Airplane Engines for Railway Locomotion.—A curious experiment has been tried in Germany to lessen somewhat the consumption of coal on the railroads by equipping a car especially built for experimental purposes with airplane engines and propellers, according to an article in the Scientific American. The car was built for standard gage track and was equipped with two standard airplane engines and propellers. The engines are of the six-cylinder type, and most likely of 275-hp. rating. One engine is mounted above the front platform on which are two barrels of fuel and apparently two automobile radiators which have been pressed into service, and the other engine and similar equipment is over the rear platform. No attempt has been made to streamline the car further than the cutting off of its forward corners so as to give an approximate wedge-shaped front end. It is stated that with 40 people aboard, this car attained a speed of 50 miles an hour.

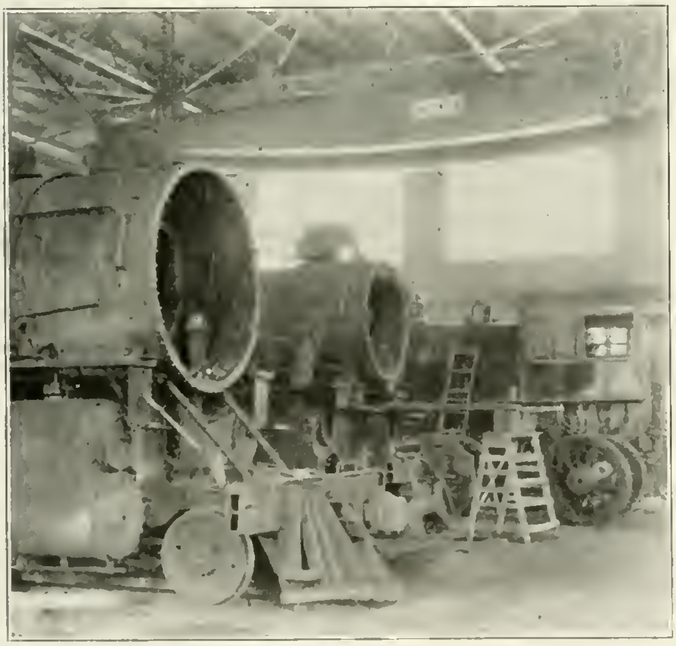


A Rear View of Terminal

M. C. Builds Engine Terminal at Niles, Mich.

New Division Point Established; Transfer made from Michigan City Without Serious Delay to Traffic

On December 9 and 10, 1919, the Michigan Central placed in operation a complete new freight engine terminal at Niles, Mich., and abandoned the operation of the Michigan City, Ind., terminal except for such locomotives as are required in local work. The new engine terminal is part of a project for the transfer of the freight terminals of the Middle and Western divisions from Michigan City to Niles in order to equalize the mileage and improve operating conditions. The Middle division formerly extended from Jackson, Mich., to Michigan City, Ind., a distance of 153 miles by the main line and 141 miles by the air line, which leaves the main line at Jackson and connects with it at Niles. The Western division, from Michigan City to Chicago, was 57 miles long. With the establishment of the new freight division point at Niles, the Middle division is reduced to a length of 116 miles by the main line and 104 miles by the air line, while the Western division is increased to a length ot 92 miles.



Interior of the Erecting Shop

The terminal includes a modern 30-stall engine house of the shed-roof type, supported by four concrete posts between each pair of stalls, a 600-ton Link Belt coaling station, two cinder pit tracks over a 125-ft. concrete pit, and a six-pit locomotive repair shop. On the side of the roundhouse nearest the cinder pit, separate buildings have been erected, one to serve as an oil house and the other to house the offices of the engine despatcher and general foreman and to provide locker room and lavatories for the engine crews. The hot water washout and filling equipment and fuel oil storage for shop use are housed in separate structures adjoining the roundhouse and the powerhouse end of the repair shop building. The master mechanic's offices occupy a remodeled farmhouse fronting on what eventually will be made the main road between the division terminal and the city of Niles. Adjoining this building and also fronting on the road has been erected a two-story $50,000 hotel, operated by the railroad company for the benefit of the engine crews.

Relation of the Drop Pit Extension of the Roundhouse to the Back Shop

In addition to taking care of running repair work in the roundhouse, the shops are designed to handle the classified repairs to the locomotives assigned to the Western division, thus relieving the main shop at Jackson, Mich. The entire

plant, including the terminal and shop, employs about 350 men, those in the terminal working in three shifts and those in the back shop in one shift of eight hours each. The terminal turns about 70 to 80 engines a day and keeps 8 to 12 yard engines in service, the number varying with the different shifts.

The shop output is expected to range, and has been running, from four to six heavy repairs and two light repairs per month. At the outset the shop was handicapped by a lack of its full quota of machine tools. As the new tools have been received and placed in operation, the output has improved.

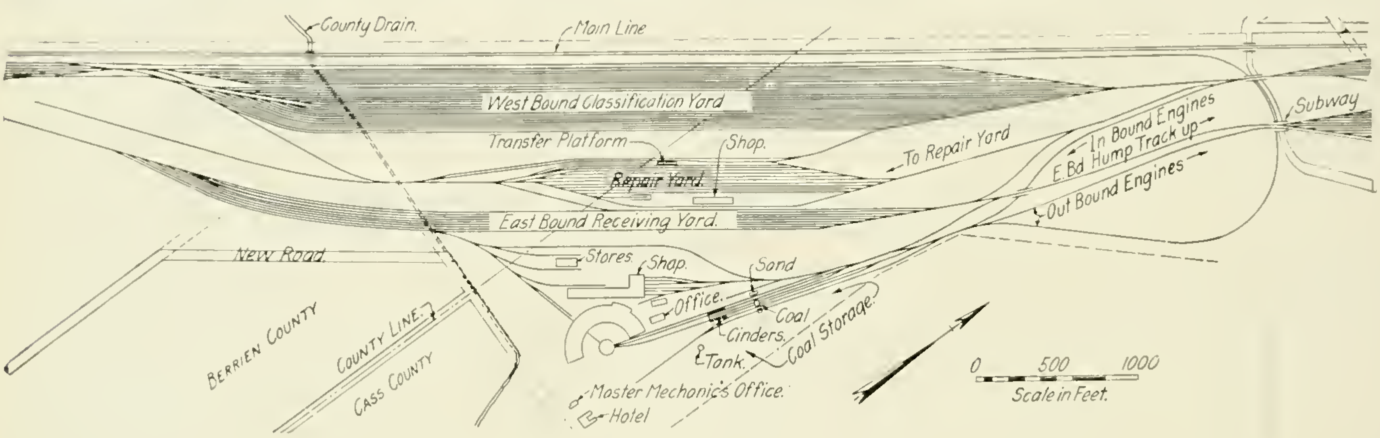
The Terminal Layout

At present only the westbound receiving and classification yards have been completed, with modifications necessary for handling both east and westbound traffic. Eventually, however, the complete project will include both east and westbound receiving and classification yards, which will modify the movement of engines through the terminal somewhat from the method now employed. The engine terminal layout consists of six tracks, two inbound, one outbound, one depressed cinder pit track, a coal-receiving track and an unloading track which passes over the receiving hopper of the coaling station. The two inbound tracks and the cinder pit track pass under the coaling station, the inbound tracks passing over the cinder pit, where cinders are dumped, wet down and shoveled by hand into cars standing on the depressed cinder track. When completed, the movement of engines in and out of the yard and through the terminal will follow the one-way plan. For outbound Western division engines this involves the use of a loop track which passes under the east and westbound humps through subways and extends alongside the entire length of the westbound classification yard to the westbound departure yard.

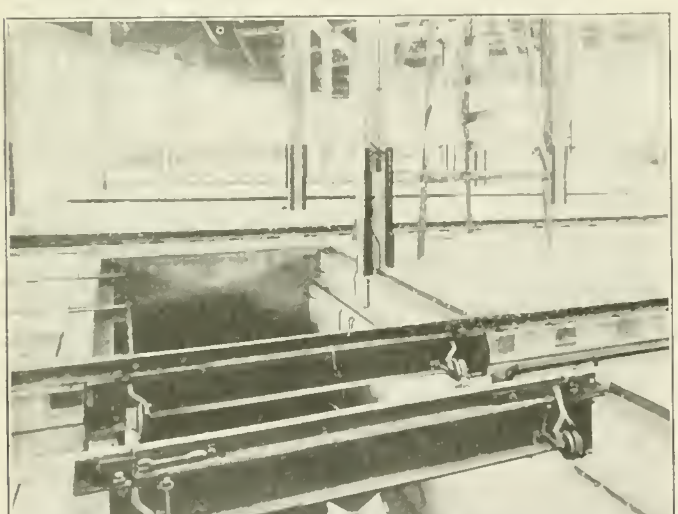
The Roundhouse

The 30-stall roundhouse is served by a 100-ft. turntable driven by a 22-hp. heavy-duty electric tractor. It has a depth of 109 ft. 9 in., with the inside circle 95 ft. in the clear from the edge of the turntable pit. The stalls are 15 ft. wide at the doors and 25 ft. 7 in. wide at the outside wall. The engine pits are 94 ft. long by 3 ft. 8 in. wide, with the sides recessed for the protection of the roundhouse heating system, which consists of four two-inch steam pipes fastened by brackets to the walls on each side of the pits. The pits have a depth of 3 ft. 6 in. at the rear ends and drain on a fall of one inch in ten feet toward a tunnel extending completely around the circle of the house at their door ends. The pit walls are of heavy, reinforced concrete 2 ft. 6 in. thick and are covered by planking, thus providing ample foundation for heavy jacking. The remainder of the enginehouse floor is covered with five inches of concrete.

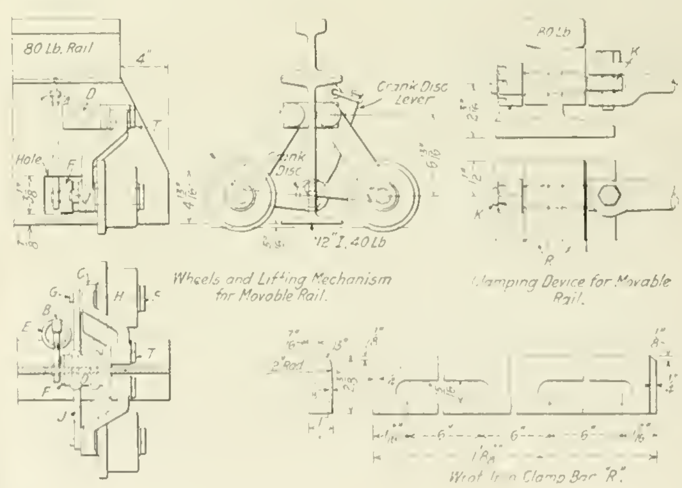
Back of the seventh to the eleventh stalls, inclusive, counting from the end of the house nearest the back shop, the rear wall is offset 12 ft. 3 in. Three of the five stalls in the extension are served by drop pits. The pit for drivers is



Layout Showing the Arrangement of In and Outbound Tracks



Arrangement of Movable Rails Over the Drop Pit



Details of Drop Pit Movable Rail Lifting and Clamping Device

located in the eighth stall at a distance of 70 ft. 10 in. from the inside wall of the house. This pit extends towards the seventh stall far enough to permit the location of the wheel track between the two stalls. The truck drop pit is located in stalls nine and ten, with the wheel track between them, at a distance of 79 ft. from the inside wall of the house.

The track arrangement at the drop pit section of the house is shown in one of the photographs. In the offset extension is placed a transverse track connected by two air-hoist operated turntables, with the wheel tracks from the drop pits. This track passes outside the roundhouse, through doors in the end of the offset extension, to another turntable and a track leading directly into the repair shop near the wheel lathe.

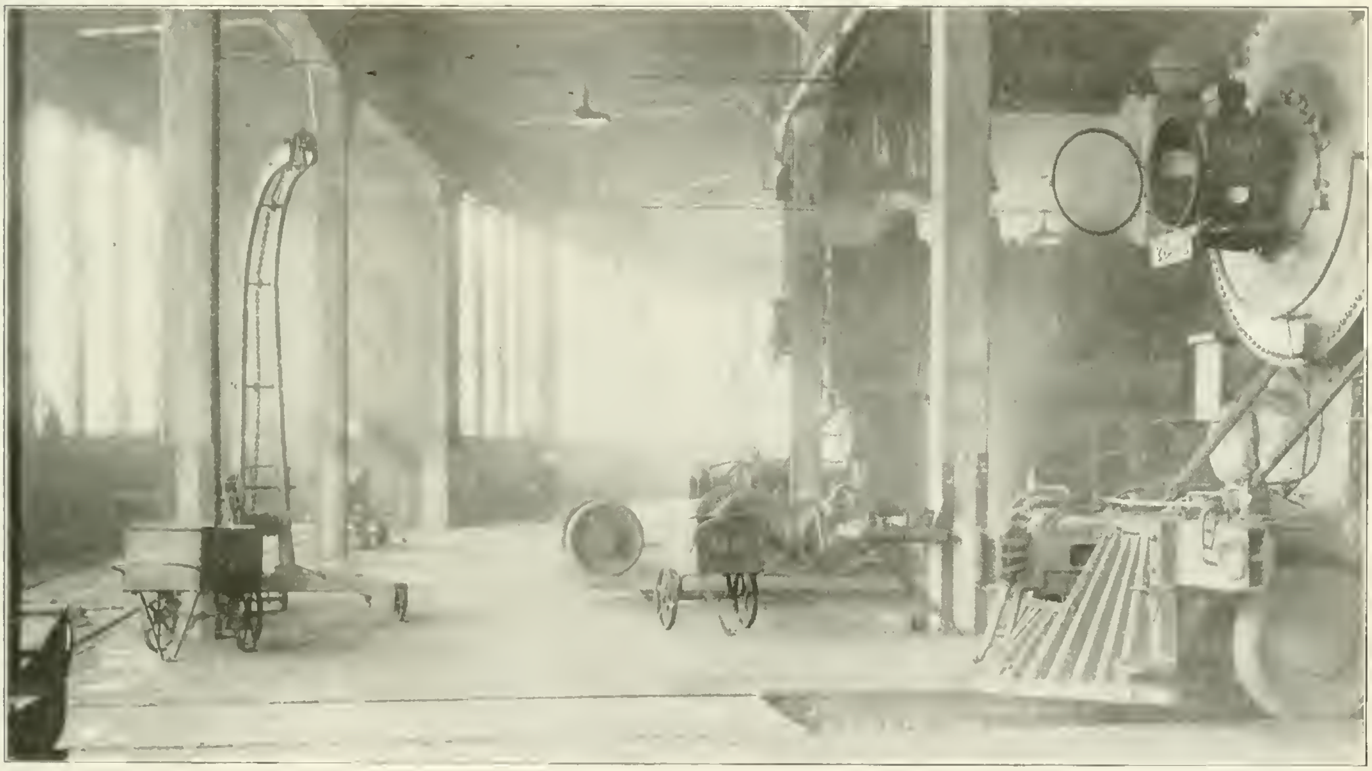
The roundhouse is provided with steam, compressed air, and cold water lines, the hot water washout and filling system lines and a fuel oil line for use in firing up. The steam blower line is carried around the house at the outside post circle with flexible pipe service connections carried down at each post. All other pipe lines are placed at the second post circle from the inside wall, the service connections being carried down at alternate posts, each set thus serving two stalls. The hot water, filling, washout and blowoff lines are carried outside or back of the posts, with the cold water, compressed air and fuel oil lines opposite. Each service outlet on the fuel oil line is fitted with a permanent hose and burner connection.

Erecting and Machine Shops

The repair shops, storehouse and power plant are housed in a single structure. This building is L-shaped, 486 ft. long and 60 ft. wide, with a 140-ft. wing, 102 ft. deep at one end. The erecting shop, which occupies the wing, is divided into two longitudinal bays 46 ft. and 53 ft. wide, with the wider bay adjoining the machine shop. A 30-ton Northern crane, with a 10-ton auxiliary hoist, travels throughout the length of this bay. There are six transverse pits in the erecting shop, spaced 22 ft. between centers. The four middle working pits are served by a continuous drop pit, the center of which is 40 ft. from the inside wall of the building and under the crane. These four pits are used for locomotive repairs, the wheeling and unwheeling being down on the drop pit. The outside working pit at the end of the wing is used for light and emergency repairs to locomotives when it is not necessary to drop any wheels. Owing to the location of the driving wheel lathe in the erecting shop, where crane service is available, the first pit does not extend the full width of the shop. At present the floor space occupied by this pit is used for carpenter shop and tank work.

Space is available for a future extension of the erecting shop at the end of the wing, as well as for the installation of a screwjack locomotive hoist.

The drop pits, both in the erecting shop and roundhouse, are designed for operation without the necessity of men entering the pits either for jacking, traversing or removing the rails. The jack is traversed along the pit by means of an air cylinder located alongside the jack track. The removable rail sections in the engine pit tracks are carried on simple elevating trucks, on which they are readily moved along the drop pit.

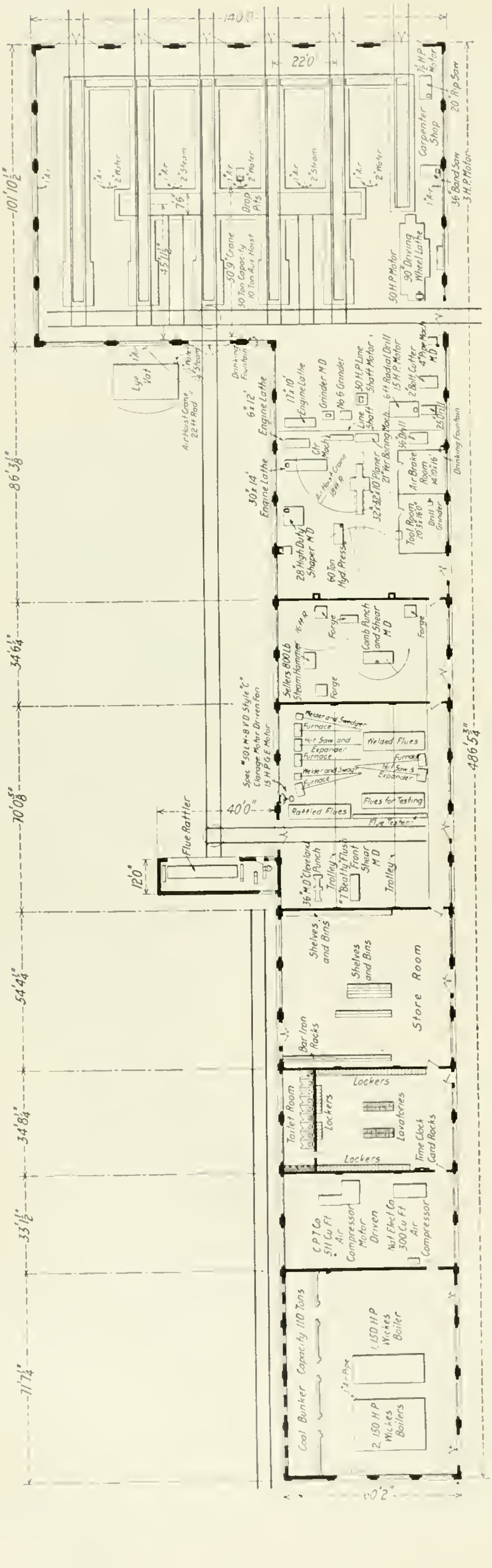


Interior of the Roundhouse, Showing the Extension at Drop Pits and the Wheel Track Arrangement

The movable rails are of 80-lb. section and are mounted on 12-in. 40-lb. I-beams. At each end two five-inch flanged wheels are attached to opposite sides of the I-beams, with swinging arms and a toggle link mechanism which permits the wheels to be lowered sufficiently to raise the I-beam free from its supports. The wheels rest on rails laid along the sides of the jack pit.

In dropping a pair of wheels, after they have been raised clear of the movable rails, the five-inch wheels are lowered by means of a lever which may be reached without entering the pit and the rail is rolled ahead of the jack to be placed in line with the wheel track after the wheels have been raised. Similarly, the other movable rail is moved up behind the jack, lowered in place, the wheels dropped on the rails and rolled off the pit. The operation of the jack and the jack traversing cylinder are controlled by valves located at the columns between the engine pits.

The machine shop occupies 86 ft. of the longitudinal por-



Plan of the Main Shop Building Including the Store and Power Plant

tion of the building adjoining the erecting shop. In addition to the old machine tools transferred from Michigan City, a number of new machines are being installed as fast as deliveries can be secured. These include a 90-in. wheel lathe, a vertical turret lathe, a 28-in. high-duty shaper and an 18-in. engine lathe. The majority of the older machines are group driven from a line shaft by a 30-hp. motor. The arrangement of the machine tools, which have already been placed in operation, is shown in the plan drawing of the shop.

Smith and Flue Shops

Adjoining the machine shop is the blacksmith shop, the two being separated by an 8-in. brick wall. The blacksmith shop occupies 34 ft. 6 in. of the building for its full width. It contains three hand forges, an open fire for large bar stock or other similar material, one 800-lb. steam hammer and a motor-driven combination punch and shear. The hammer, one of the hand forges and the open fire are under the swing of a 16-ft. jib crane and a smaller jib crane swings over the punch and shear.

The flue shop, which adjoins the blacksmith shop, is 70 ft. long and is closed at either end by 8-in. brick walls. Near the farther end of this shop a dry flue rattler is housed in a small structure built out from the side of the building adjoining the erecting shop wing. Counting from the machine shop end, the track over the third working pit in the erecting shop passes through the wing and is continued to the flue rattler. Provision is thus made for the movement of tubes from the erecting shop to the rattler, and thence they are moved directly into the flue shop on a transverse track connected with the longitudinal track by a turntable.

From the floor plan it will be seen that the path of the tubes through the shop is in the form of a loop starting from and ending at the transverse track, where the tubes are loaded on trucks for the return movement to the erecting shop.

The equipment of this shop consists of a welder and swager for superheater flues, a Ryerson combined hot saw and air-operated swaging and safe-ending machine for 2-in. tubes, a hot saw and expander for the front tube sheet ends of 2-in. tubes and a hydraulic tester. The swaging and welding machines are served by Economy combustion chamber furnaces burning fuel oil.

The Power Plant

The remainder of the building is occupied respectively by a 54-ft. store room, lavatory, locker and toilet rooms 35 ft. long, and the power plant. The latter is divided into two sections, the first of which occupies 33 ft. of the building and contains two air-compressors, one a new belt-connected, motor-driven compressor furnished by the Chicago Pneumatic Tool Company, of 511 cu. ft. capacity, the other a direct-connected, motor-driven compressor of 300 cu. ft. capacity, which was moved from the Michigan City shop.

The boiler room is 71 ft. 7 in. long, and at the present time contains three 150-hp. Wickes boilers, with room for the addition of two more units of the same size. An enclosed coal bunker of 110 tons' capacity is built in along one side of the boiler room. Along this side of the building is located a track which serves both the store room and the coal bunker.

All power for machine-tool drives, welding and lighting is three-phase, alternating current, furnished by the Indiana-Michigan Power Company of South Bend, Ind., at 4,000 volts, with transformers installed at the shops. The power and welding circuits are stepped down to 440 volts, while the lighting circuits are taken from a three-wire, 220-volt transformer, with the circuits arranged for 110-volt lamps.

Lighting

Both the shops and the roundhouse are lighted by 200-watt lamps in Maxilight reflectors. In the shops the lamps are suspended from the under side of the roof trusses. In the

roundhouse the wiring conduits and fixtures are carried on messenger cables suspended along each radial row of posts about 14 ft. above the floor. Each row carries two lights, alternating respectively between the middle of the first and third bays and the middle of the second and fourth bays. Drop cords for use with extension cord lamps are located near the second and third posts in each row.

The roundhouse eventually will be wired with a 440-volt circuit to permit the use of electric welding apparatus.

The Transfer from Michigan City

The placing in operation of the new terminal involved problems not usually encountered when moving into new shops. Practically a complete transfer of shop tools and equipment, material and working forces from Michigan City to Niles, a distance of 37 miles, was required. The distance made it necessary to arrange the transfer so that practically full running repair work could be continued at Michigan City to within a few hours of the time that all work was to be handled at Niles.

About a week before the proposed change all of the heavy machine tools, including the old wheel lathe, were moved to Niles, leaving only such of the smaller tools as were absolutely essential to maintaining running repairs at Michigan City. On December 8 and 9 a gang of machinists was sent to Niles to connect up and place the tools in operation.

From noon of December 9 all westbound Middle division trains were stopped at Niles and eastbound Western division trains were run through Michigan City to Niles. Enough mechanics were sent to Niles on the morning of the ninth to take care of the gradually increasing business from noon of December 9 to the morning of December 10.

On the evening of December 9 six cars of supplies and one car fitted up as a temporary tool room were despatched from Michigan City, arriving at Niles in time for the 6 o'clock morning business. By December 11 the new terminal was practically in full operation and only such power remained at Michigan City as had not yet been despatched following its arrival prior to noon of December 9. As rapidly as possible the supplies and tools were removed from the cars to their permanent quarters in the shop building. Most of the men still reside at Michigan City, and special shop trains are operated between Niles and Michigan City for their benefit.

The change was made with a minimum of light-engine mileage and no serious delays to traffic resulted, although some time was required to get the terminal as a whole to working smoothly. As has been stated, only the westbound receiving and classification yards have at present been completed with modifications necessary for handling both east and westbound traffic. The principal handicap in this respect was the fact that the eastbound yards were required to handle both east and westbound traffic, rather than any condition in the engine terminal itself.

FREDERICK J. HARRISON

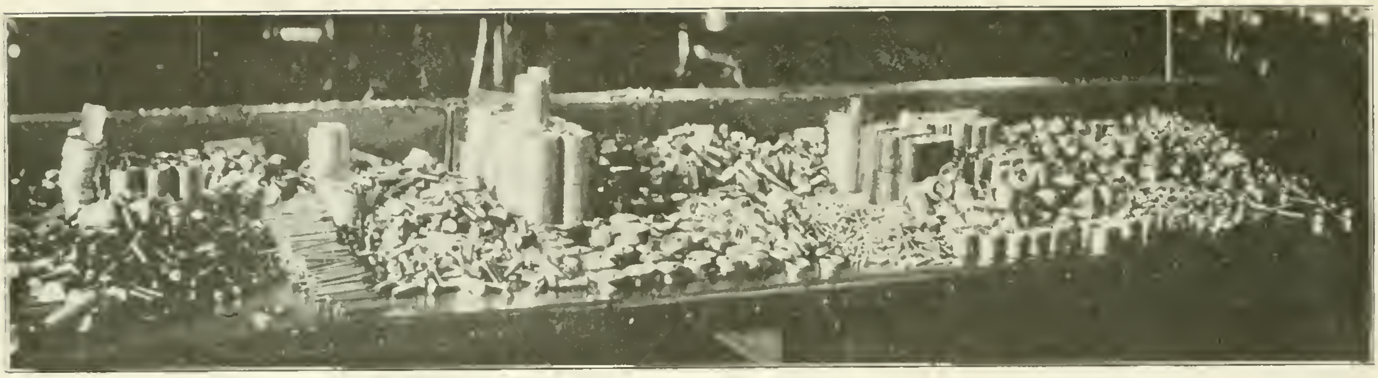
Frederick J. Harrison, superintendent of motive power of the Buffalo, Rochester & Pittsburgh since 1910, died at Du Bois, Pa., on April 16, following an illness of several months resulting from pneumonia. As superintendent of motive power of the Buffalo, Rochester & Pittsburgh, Mr. Harrison had full supervision over the executive and technical duties of the motive power department, which although not as large as that on many railroads was generally regarded as a model with respect to management and perfection of mechanical detail.

Mr. Harrison was born in Rochester, N. Y., on February 22, 1864, the son of Joseph Harrison, who was one of the old engineers on the New York Central. He attended school until he was 14 years of age and then started to learn the machinist trade, which vocation he followed for 11 years, being connected during this time with the Gleason Machine Works and the Graves Elevator Works. He then became a fireman on the New York Central, remaining in that service for about three years, sending in his resignation just one day before he was to be promoted to engineer. He resumed work as a machinist in October, 1888, in the shops of the Buffalo, Rochester & Pittsburgh at Rochester. In 1890 he was placed in charge of the shops as machine foreman and in 1894 was made general foreman in charge of the locomotive and car works at that point, which position he held for six years.

F. J. Harrison

In 1901 Mr. Harrison accepted a position as general foreman at the Du Bois Iron Works, but shortly after moving to Du Bois he re-entered the service of the B. R. & P. as general foreman of the shops then in course of construction at Du Bois. He supervised the installation of machinery, thus starting the new work at this point. Mr. Harrison was promoted to the position of master mechanic in 1904, having charge of the locomotive and car works not alone at Du Bois, but all points between East Salamanca and Pittsburgh. In 1910 he became superintendent of motive power.

Mr. Harrison was practically and thoroughly educated in his line of work. His judgment was held in high esteem by officials of the railroad with which he was connected, and his opinion and advice were sought at all times. Mr. Harrison had the opportunity to become more prominently identified with the activities of the community in which he was located than many railroad officials who are situated in larger centers, and it may be said that he contributed much toward establishing a friendly understanding between the public and the railroad that he represented. He was a prominent Rotarian and was affiliated with other local and Masonic organizations. Although Mr. Harrison held a position that frequently brought him in opposition to employees of the railroad, he always retained their confidence and a reputation for fair and square dealing that is recognized today as so important a factor on all railroads.



Output of Automatic Machines on the Inspection Bench

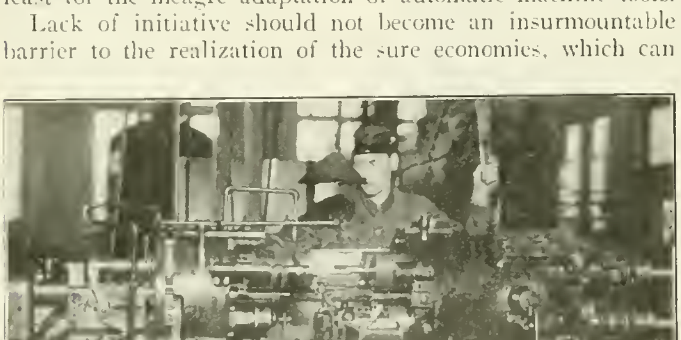
Automatic Machines an Aid to Economy

Work for Which Various Types Are Adapted; Minimum Quantity Economically Produced on Automatics

BY GEORGE W. ARMSTRONG

Automatic machine tool installations offer a possibility for reducing maintenance of equipment expense which has been largely overlooked. The urge has not been as imperative in the past as at present; due to the higher labor rates and individual decreased productive efficiency. Human nature is so constituted that it normally follows the line of least resistance. This results often in a tendency to stick to the old way, the means that are familiar, rather than to investigate and develop the latent possibilities of the unknown and untried. This may account in part at least for the meagre adaptation of automatic machine tools.

Lack of initiative should not become an insurmountable barrier to the realization of the sure economies, which can be effected through the acquisition of such valuable shop adjuncts. Their possibilities are not untried and unknown. Automatic screw machines have been in successful operation in railroad shops since 1900 and automatic chucking and turning lathes since 1905. Automatic screw machines are now being operated on eight or ten roads with profit, while automatic chucking and turning lathes are similarly successfully operated on three roads.



A Multiple Spindle Automatic

The degree of usefulness of automatics is further well illustrated by the scope of two large railroad installations. One road has 12 single spindle automatic screw machines, 4 multiple spindle screw machines, 16 automatic chucking and turning lathes and 3 automatic chucking lathes. The other has 34 single spindle automatic screw machines, 14 multiple spindle screw machines, 15 automatic chucking and turning lathes and 4 automatic chucking lathes. And this latter road is figuring on additional machines.

The Field for Automatics

Automatic machines are desirable in that more than one machine can be cared for by one operator because of the automatically controlled tool movements, spindle speed and feed changes. They are further, especially advantageous, due to the feature of mechanical output pacing. Manual labor in machine tool operation is largely transferred by automatic machines from the man to the machine. Productive capacity is controlled by fixed work cycles and the output expected is therefore definitely fixed, except for the contingencies of tool grinding, resetting tools and minor delays. This desired output is being used by at least two roads as a mark to shoot at, and the best of co-operation secured in realizing and often bettering this mark. Mechanical control of production as given by automatic machine operation has been a satisfactory means of securing uniform output and leveling the peak.

Automatic machine tool operation does not lend itself to promiscuous shop installation; to secure full benefits centralized installations should be made. Attaining full productive capacity requires that they be grouped at one point, where tooling equipment can be made and maintained, and where an organization can be built up to care for them. The automatic machine as now developed with standard tooling equipments is not a difficult machine to operate; standard cams have been developed too, which will take care of all usual ranges of work and these are very easily removed and reapplied.* Grouping of machines at one point, results in reduction of the idle investment in these auxiliary parts, as well as securing an experienced trained force to successfully devise the best uses of standard tools, and develop any special tools which may at times be required.

The natural result of centralized installation of automatic machines is the centralized production of parts and standardization as far as possible of suitable parts for such production. This, however, should not be a deterrent but a decidedly beneficial by-product. Centralized production of

*For a discussion of the operation of automatic machines, see article "Automatics in Railroad Shops," published in the *Railway Mechanical Engineer* issue for June, 1919, page 303.

largely used repair parts exerts a greater improvement in roundhouse maintenance than in shop operation and individual part cost economy. The effect in roundhouse operation is largely an intangible one from a dollars and cents standpoint, but an important one. Having in stock a finished or semi-finished part may often mean the difference of hours in returning an engine to service, and may in many instances prevent the loss of an engine on its regular run.

Types of Automatic Machines

Many types of automatic machines are available, but the particular type best suited depends upon the nature of the work. The following is a list of representative automatic machines of the more common types.

Automatic Lathes	Fay automatic. Reed-Prentice automatic. Le-Blond Multi-cut.
Automatic Chucking and Turning Lathes	Potter & Johnston. Gisholt.
Automatic Chucking Machines	New Britain. Bullard Mult-av-matics.
Automatic Screw Machines, Single Spindle	Gridley. Brown & Sharpe. Hartford. Cleveland.
Automatic Screw Machines Multiple Spindle	Gridley. National Acme. Radical. New Britain. Cincinnati. Cone.
Automatic Milling Machines	Cincinnati. Potter & Johnston. Pratt & Whitney.

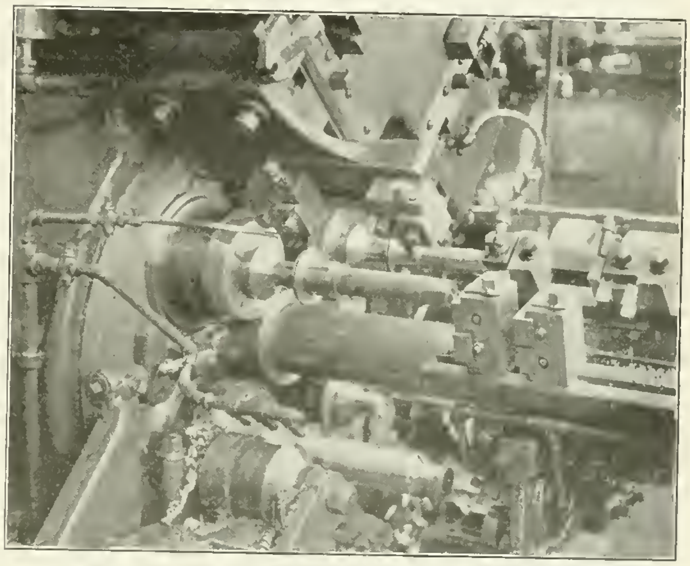
Best Types for Handling Various Kinds of Work

Automatic Lathes.—The automatic lathe is adapted for straight multi-diametered work with limited facing requirements. Front, back and intermediate crank pins are within its scope, but require the use of an auxiliary machine for threading, preferably a thread milling machine. Crosshead and knuckle pins could be similarly finished, and also motion work pins where the quantities required are too small to justify the use of automatic screw machines, or where a large head makes turning from a forging more economical than from bar stock. Flanges, crank pin collars, and similar work requiring only turning and facing can be admirably handled on this type of machine by using mandrels.

Locomotive Parts Produced on Automatic Screw Machines

Automatic Chucking Machine.—The automatic chucking machine is best adapted to boring, reaming and facing operations on small castings or forgings which can readily be held in chuck jaws. Its high productive capacity makes it suitable only for large quantity runs. This type of machine has five or more chucks with four or more tool working stations. The chucks are indexed so as to present the work to the respective tool stations in sequence. Work is therefore finished in the time required to perform the longest single operation, plus the time required to index the head. Removing and chucking pieces is done at the same time that machining is being done.

Multiple Spindle Screw Machine.—The multiple spindle automatic screw machine should be used where large production runs are available as staybolt sleeves, link bushings, set screws, etc. The use of the multiple spindle machine, however, is not advisable for initial installations, general use and large diametral capacity, for which purposes



A Typical Tool Set Upon a Multiple Spindle Screw Machine

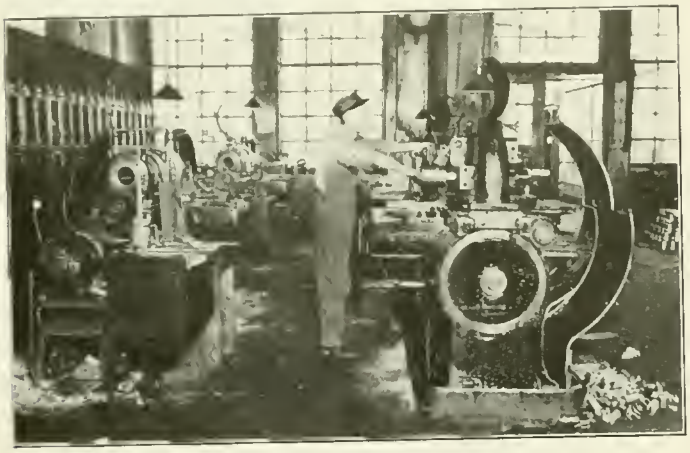
the single spindle automatic screw machine is better suited. Where the quantities required are large the multiple spindle machine is desirable as it combines four or more machines in one, and the work is produced in the time of the longest single operation plus the time to index the spindle head. Tools are operated on each bar in succession, cutting off the finished piece in the fourth position, ready to feed the bar forward as the head indexes. Production time can be reduced by dividing the longest operation between two spindles wherever possible, for example, a long turning or drilling operation. Threading can be done on an automatic screw machine, but it will usually be found that greater production, due to higher cutting speed and feed, can be secured if threading is done independently, preferably on a bolt threading machine. Where a set-up man is employed, a substantial reduction can be effected by using a machinist helper to thread parts and the set-up man to adjust the dies.

Automatic Milling Machine.—The automatic milling machine has been very little utilized in railroad shops except for milling square and hexagon bosses on caps and similar pieces. Aside from the Potter & Johnston machine, those available are rather restricted in scope which may partly account for this fact. Then, too, the latest type of plain, knee type milling machines are equipped with trip dogs for table movement which make them semi-automatic in operation. However, there is considerable milling work in large quantities as rod keys, piston keys, shoes, etc., which could be profitably handled on automatic milling machines and deserves consideration.

Automatic Chucking Machine.—The automatic chucking machine is well adapted to finishing castings and forgings.

Tool set-up is virtually that of good turret lathe practice, using multiple tooling set-ups, for simultaneous turning, boring, drilling or reaming with turret face and facing with the cross-slide. The turret travel and indexing, cross-slide movements, spindle speed and turret and cross-slide feeds, as well as the co-ordinated operation of turret and cross-slide are controlled by trip dogs and cams on the cam shaft in the base of the machine. The articles to be machined are usually held by means of a regular convertible two-jaw to three-jaw universal lathe chuck, fitted in most cases with false jaws. Wherever it is possible to true the false jaws in place, they are left soft and frequently trued up to maintain accuracy, especially where holding a turned surface for a second operation.

All operations of this type of machine are automatically performed after the piece is chucked and the starting lever thrown off. At the completion of the cycle, the machine is automatically tripped and stopped, thus preventing a repetition of the cycle and possible spoiling of work should the operator be occupied elsewhere. This feature can also be made use of in tapping or threading with a collapsing tool. To insure the operator's attention during this operation, the threading tool can be placed on the first face, so that the automatic trip feature stops the machine prior to this operation. It then requires the operator to start the machine for



A Battery of Automatic Chucking Machines

threading or tapping and to also stop it again to remove the piece and chuck a new one.

This type of machine is now being used for a wide range of parts, some of which are given below.

Bell ringer cylinders.
Bell ringer pistons.
Air pump piston heads.
Tank hose nuts.
Injector pipe nuts.
Crosshead pin nuts.
Knuckle pin nuts.
Air pump packing rings.
Oil cup covers.
Packing sliding plate rings.
Injector flanges.
Crank pin collars.
Knuckle pins.
Air valve cages.
Eccentric rod bushings.
Piston valve bull rings.
Piston valve packing rings.
Boiler check bodies.
Grease cup covers.
Knuckle pin bushings.

Single Spindle Screw Machines.—The single spindle automatic screw machine has perhaps the largest field in railroad shops. The set-up required is less complicated than that of the multiple spindle automatic screw machine, and the range in the diameter of bar greater. This greater simplicity in tooling and camming makes it possible to utilize it for much work in quantities too small for economical multiple spindle production and which would otherwise require the use of a turret lathe. Turret lathes have a very wide field of usefulness in railroad as well as industrial shops which has by no means been fully developed. However, the turret lathe requiring individual attention and operation should not be used, where runs of articles are required in quantities adapted to automatic machine production and consequent multiple machine operation.

Automatic screw machines, single and multiple spindle, are used in railroad shops for finishing the following parts:

Crosshead shoe bolts.
Spring bolts.
Brake bolts.
Reach rod bolts.
Trailer box bolts.
Patch bolts.
Eccentric rod pins.
Valve rod pins.
Motion work bushings.
Link pins.
Throttle lever bolts.
Lubricator connections.
Staybolt sleeves.
Taper pins.
Cap screws.
Spring rigging bushings.
Spring rigging pins.
Lift shaft bolts.
Rod dowels.
Eccentric set screws.
Brake rollers.
Studs.
Reversing valve plates.
Oil cups.
Main rod key washers.
Nuts of various kinds.
Packing glands.
Valve stems.
Set screws.

Operation of Automatics

Two to four automatic screw machines are being handled easily by one operator and generally two automatic chucking and turning machines. The automatic chucking lathe is a multiple chuck machine and requires one man per machine. Many industrial installations have been made where the operator takes care of an automatic chucking and turning machine and one or two single or multiple spindle automatic screw machines, which practice might be followed in initiating railroad installations.

Complete, detailed records should be kept of the camming and tool set-up for each job, so as to prevent the necessity of the operator remembering the set-up or as is more often the case, working it out again, which is necessarily a waste of time. This record will also serve to preserve the best set-up features and insure maximum production at all times. Record sheets are generally furnished by the machine manufacturer on request.

Maintenance of Automatics

The operating statistics of one large railroad installation may be of interest as showing what has been accomplished with automatic machines and also to show that they are not difficult machines to maintain in repair. With the exception of abnormal allowance for one group of two machines, the figures show very good performance, and demonstrate that automatic machines are consistent producers with little delay for repairs.

Operating Statistics, Automatic Machines

Year	No. machines in operation	Hours per machine: Man assigned to other duties	Man off	Making repairs	Actual time working and setting up
Potter & Johnston					
1917	6	159.0	181.4	225.5	1,598.2
1918	12	314.8	500.8	113.5	2,060.5
1919	16	177.9	153.2	69.23	1,792.9
Average		222.86	280.9	112.5	1,823.6
Gridley 3¼ in. Single Spindle					
1915	2	....	1,120	536.0	2,941.0
1916	2	....	643.75	1,057.5	3,529.75
1917	2	218.75	51.5	1,414.25	915.5
1918	2	28.5	258.0	652.0	1,950.25
1919	2	136.0	355.0	964.5	908.25
Average		76.65	485.7	924.9	2,046.95
Gridley 2¼ in. Multiple Spindle					
1918	4	356.0	680.0	581.0	2,061.9
1919	4	65.6	181.9	231.0	2,824.4
Average		77.34	175.4	418.6	2,442.1
Gridley 4¼ in. Single Spindle					
1918	5	139.9	332.2	258.3	2,125.7
1919	9	98.5	165.3	82.2	2,940.5
Average		132.2	224.9	145.1	2,649.3

Minimum Economical Run

The question often uppermost in the mind of the man considering automatic machine operation, or contemplating new work on his existing installations, is, "What is the minimum quantity I can afford to run?" An accurate answer must necessarily require accurate data which would not be available. However, an approximate solution which will fulfill the object desired can be secured from previous similar performances or conservative estimated time. The same method can also be employed to determine accurately the

quantity after actual operating figures have been developed.

The minimum economical production will necessarily be such a quantity that the automatic machine cost will be equal to the cost on the turret lathe. Material will not differ in either case, where good practice prevails, so that this item can properly be disregarded. This will be true except in the limited cases where forgings might be used in turret lathe practice, whereas the automatic screw machine would produce from bar stock. Forging cost will often serve as ample offset to the extra material cost, or else the use of the proper automatic machine will again duplicate turret lathe procedure in finishing the forgings. Direct labor cost and overhead expense are therefore the determining factors governing the minimum economical production.

Let s = set-up time in hours on the automatic
s_1 = set-up time in hours on the turret lathe
t = production time in hours per piece on the automatic
t_1 = production time in hours per piece on the turret lathe
n = number of pieces to be finished
q = number of automatic machines operated per operator
r = hourly rate of the automatic operator
r_1 = hourly rate of the turret lathe operator
R = hourly rate of the automatic set-up man
O = rate in per cent of automatic overhead expense
O_1 = rate in per cent of turret lathe overhead expense

The cost on the automatic machine will be

$$s(r+R) + \frac{ntr}{q} + \frac{O}{100}\left[s(r+R) + \frac{ntr}{q}\right]$$

The assumption has been made that while setting up a machine the other automatic machines in the individual battery will be idle. While not strictly true for automatic screw machines, until material being worked on is cut up, it will be realized that this assumption is an error on the side of safety, as the benefit is given for any production resulting during the time of setting up.

Also the cost on the turret lathe will be

$$s_1 r_1 + n t_1 r_1 + \frac{O_1}{100}\left[s_1 r_1 + n t_1 r_1\right]$$

Equating and solving we have

$$n = \frac{\left[\left(1+\frac{O}{100}\right) s(r+R)\right] - \left(1+\frac{O_1}{100}\right) s_1 r_1}{\left(1+\frac{O_1}{100}\right) t_1 r_1 - \left(1+\frac{O}{100}\right)\frac{tr}{q}}$$

Solving this equation will give the minimum economical production run for any particular job to compete with turret lathe operation. Illustrative of its practical application we will assume a typical case, and solve for the economical quantity.

Let s = automatic set-up time be 4 hrs.
s_1 = turret lathe set-up time be .5 hrs.
t = automatic production time be .1 hr.
t_1 = turret lathe production time be .25 hr.
r = automatic operators rate .72 per hour
r_1 = turret lathe operators rate .76 per hour
R = Set-up man's rate .84 per hour
q = automatics per operator, 2
O = overhead on automatics 175 per cent
O_1 = overhead on turret lathe 60 per cent

Then

$$n = \frac{\left[\left(1+\frac{175}{100}\right) 4\,(.75+.84)\right] - \left(1+\frac{60}{100}\right) .5 \times .76}{\left(1+\frac{60}{100}\right) .25 \times .76 - \left(1+\frac{175}{100}\right)\frac{.1 \times .72}{2}}$$

Solving

n or minimum production = 44.3 pieces.

Automatic machines have been a profitable investment for the railroads now using them. The statement was recently made that two months' production on one multiple spindle automatic screw machine saved enough to pay for the machine. This was an exceptional result, but the possibilities for economy are large.

Automatic machines will produce and they will produce uniformly. The care and attention required to effectively maintain an automatic machine is no more than that which should be accorded any other machine tool. The unfavorable contrast where it does exist is due to an inferior maintenance of general purpose machine tools, and that an engine lathe "shot to pieces" can be made to produce where an automatic machine will not effectively.

Labor rates are high and will continue high, individual productivity is low and may be improved in time; but automatic machine installations offer a certainty of consistent increased output and decreased expense.

VALVE GEAR JAW BOLT, FOR RADIUS ROD AND VALVE STEM CROSSHEAD

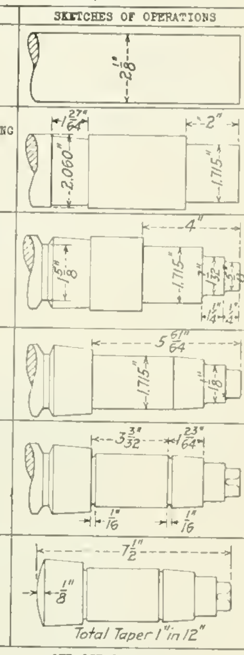
REF. 13-20855 TRAC. A.S.70

MATERIAL 2-1/8"RD. BESSEMER STEEL LBS.PER 100 800 LBS SCRAP

MIN.QUANITY TO BE ORDERED OUTPUT PER HR. AT 100% 29
" " " ACTUAL

MACHINE 6 SPINDLE NEW BRITAIN MULTIPLE 2-1/2" x 9-1/2"

POSITION	TOOLS	OPERATIONS	SKETCHES OF OPERATIONS
1	STOP	FEED STOCK 7-11/16" C.S. 103' - 0" FEED .007"	
2	B.T.6 C.R.3/4"SQ.USED IN BT 6 R.C.204 F.O.538	FORM HEAD TURN END 1.715" x 2"LONG	
3	B.T.7 C.R.3/4"SQ.USED IN BT 7 2 tools C.R.3/8"SQ.USED IN B.T.7 R.C.205 F.O.14	FORM FOR CUT-OFF TO 1-5/8" DIAMETER TURN 1.715" x 2" LONG ROUGH TURN 1-7/32" x 1-1/4" LONG TURN END 5/8" x 1/4" LONG AND FACE	
4	B.T.8 C.R.3/4"SQ.USED IN BT8 C.R.3/8"SQ.USED IN BT8 C.R.3/8"x 1-5/8" USED IN B.T.8	TURN 1.716"x 1-51/64" LONG TURN TAPER END TO 1-23/64"LONG FINISH TURN THREADED END TO 1-1/8" DIA.	
5	E.X.3 R.C.4 T.O.511 (2 TOOLS)	RECESS AT TWO POINTS 1/16" WIDE 1/16" DEEP CENTER END	
6	B.C.3 T.O.512	CUT OFF AND RADIUS HEAD	



LEAD CAM C.U. 2-1/16" TAKE BACK CAM C.W. 23 CUT OFF CAM C.X.21

UPPER FORMING CAM C.X.16 LOWER FORMING CAM C.X.15

DRIVING GEARS 32 and 58 CAM SHAFT FEED GEARS 50 and 130

SPINDLE SPEED 187 CHUCK C.C.3 PADS C.P.149 FEED FINGER F.C.106 PADS F.P.18

REMARKS: EXTRA OPERATIONS: 1. CENTER LARGE END. 2. DRILL HOLES. 3. THREAD TO WELLS LIMIT GAUGE 4. CASEHARDEN. 5. GRIND BODY TO SIZES SHOWN ON TRACING A.S.70

Form for Recording Setup of Multiple Spindle Automatic

Ranges in Steam Consumption by Prime Movers

Fuel consumption is the direct result of water evaporated and evaporation depends on the steam demands of the engine. The following table shows steam consumption under average plant conditions for different types of engines using saturated steam compared with those using superheated steam at 100 deg. and at 200 deg. superheat.

Type Engine	Steam consumption, lb. per hp. hr. Saturated steam	100 Deg. superheat.	200 Deg. superheat.
Simple non-condensing	29-45	29-38	18-35
Simple non-condensing automatic	26-40	18-34	16-30
Simple non-condensing Corliss	26-35	18-30	..
Compound non-condensing	19-28	15 25	13-22
Compound condensing	12 22	10-20	9-17
Simple duplex steam pumps	120-200	80-160	....
Turbines non-condensing (kw. hr.)	28-60	24-54	21-48
Turbines condensing (kw. hr.)	12-42	10-38	9-34

Depending on the efficiency of the engine itself, it will be seen that superheating shows substantial economies in steam consumption. It should be noted, also, that the percentage of savings varies from 9 to 33 per cent for 100 deg. superheat to from 19 to 38 per cent for 200 deg. superheat.—*Power Plant Engineering.*

Air Brake Association Holds Live Convention

Important Problems Dealt with from Standpoint of Effect on Revenue and Operating Efficiency

SUBJECTS having an important bearing on railroad operating conditions were discussed at the twenty-seventh annual convention of the Air Brake Association, which opened on May 4, at the Hotel Sherman, Chicago.

Following the usual opening exercises, Frank McManamy, manager department of equipment, Division of Liquidation of Claims, United States Railroad Administration, delivered an informal address, which was followed by the address of T. F. Lyons, president of the association.

Mr. McManamy's Address

In his talk Mr. McManamy offered two suggestions for the consideration of the association. He first drew attention to the comparatively small number of men who are charged with the responsibility of supervising the maintenance and operation of air brake equipment. This was brought out forcibly by comparison with the equipment under the supervision of the road foreman of engines. Each road foreman supervises the operation of the locomotives on one division or less, these locomotives always remaining on the division and running into one or the other of the terminals at least once every 24 hours where they are available for necessary repairs. Usually one air brake supervisor, alone or with comparatively few assistants, must supervise the air brake equipment in operation on an entire system, much of which, in the case of freight cars he may never see but once during its life.

Mr. McManamy suggested that air brake departments need reorganization to provide more supervisors directly responsible for air brake conditions, to provide adequate equipment for making repairs, not at one terminal alone, but at every terminal on the road and he pointed out that to secure these things the support of the management must be secured. As one means of securing this needed support, he recommended that the Air Brake Association affiliate with the American Railroad Association, as such affiliation would bring the recommendations of the air brake men of the country in a position to receive the backing of an authoritative body.

In closing Mr. McManamy paid a high tribute to the support given the Railroad Administration during its period of control by the members of the association and other railroad men.

Address of the President

In his address, President Lyons dealt particularly with the advantages of attendance at the convention and the responsibility of the members to participate in the activities of the association. Foremost of these is the responsibility of taking such an interest in the discussion as will insure that each subject is thoroughly covered, the time and labor expended in the preparation of papers and committee reports for presentation meriting the most careful attention by the members. Among the benefits which the members receive from convention attendance, Mr. Lyons dwelt on the opportunity to talk shop with other air brake men outside the convention hall, from which talks are received many valuable suggestions directly applicable to the solution of his own problems by each member.

T. F. Lyons (N. Y. C.)
President

L. P. Streeter (Ill. Cent.)
First Vice-President

Mark Purcell (Nor. Pac.)
Second Vice-President

BETTER MAINTENANCE OF AIR COMPRESSORS*

By Mark Purcell
General Air Brake Inspector, Northern Pacific

When direct inquiry is made, the usual impression is that compressors are giving good service. At the same time service records may show a large amount of wheel sliding and breaking in two of trains that, at first, does not appear to have any relation to the manner in which the compressors are operating, for which the compressor is largely responsible.

If a compressor runs slow, or for any reason raises pressure slowly, there may not be enough accumulated after a brake application to make a proper release, with the result that a part of the brakes only are released and wheels are slid or drawbars pulled out. Still the compressor has not actually refused to work.

Most of the low efficiency and some of the failures are due to lack of repairs, or the quality of the repairs made being often only slightly below the standard required. In

*Submitted by the North West Air Brake Club.

some cases it is an error in a single feature, but more often a combination, such as a number of leaks, any of which may be too slight to cause trouble, yet when combined are serious. The above applies more particularly to compressors having steam and air cylinders compounded, on account of the balancing effect that may be caused by leakage.

It is not uncommon to find a compound compressor that is chronically inefficient, and be advised that one part after another has been repaired or replaced, until all or nearly all of the working parts have been gone over, and yet the operation is not improved.

In one case an 8½ in. cross compound compressor developed pounding, would not supply sufficient air, and the engine had to be taken off an important train. Examination showed that the rings in both the high and low pressure air pistons were 3-16 in. to 5-16 in. open at the ends and lacked about .0012 in. of filling the ring grooves. New rings that would fit the cylinders, .0012 in. smaller than the grooves, were applied to both the air pistons, and the compressor gave good service for four months, and probably longer.

Another 8½ in. cross compound compressor pounded to some extent and ran so slow with 190 lb. steam pressure that it would not keep up 90 lb. standard brake pipe pressure on a regular passenger train of 10 cars, against normal leakage. Examination showed:

(a)—Main steam and air cylinders slightly worn.
(b)—Steam cylinder head parts in good condition.
(c)—Main steam and air pistons about 1-32 in. smaller in diameter than their cylinders.
(d)—Packing rings in steam and air cylinders came together at the ends in the smallest part of the cylinders and were a little less than 3-32 in. open in the largest parts of the cylinders.
(e)—Rings lacked .005 in. to .008 in. of filling the grooves in the high pressure steam cylinder
(f)—Rings in the low pressure steam cylinder lacked .0012 in. to .0015 in. of filling the grooves.
(g)—Rings in the high pressure air cylinder lacked .0015 in. to .0018 in. of filling the grooves.
(h)—Rings in the low pressure air cylinder lacked .0012 in. to .0015 in. of filling the grooves.
(i)—The upper final discharge valve had 3-16 in. lift, one upper intermediate valve had 7-32 in. lift and the other air valves had only slightly more than standard lift.

New pistons that would fit the cylinders closely at the smallest part, and in which the rings fitted the grooves with just enough clearance to expand by their own tension when compressed into the grooves, were applied and no other repairs made. The compressor was given a severe running test in which its capacity and speed were fully up to the standard.

Recommended standards to cover repairing and adjustment of the different parts of compressors have been published extensively and discussed ever since the cross compound compressor came into use, but general observation would indicate that these appear seldom to be considered in connection with compressor maintenance. The general standard of service of these compressors is thus considerably below what may reasonably be obtained at slightly increased cost, by simply following standards such as those outlined in the recommended practice by the Air Brake Association.

The number of engine failures chargeable to the air compressor alone, indicates the need for improved compressor maintenance, and this is emphasized by the other troubles that can readily be traced directly to a lowered compressor efficiency.

G. H. Wood (A., T. & S. F.)
Third Vice-President

F. M. Nellis (Westinghouse Air Brake Co.) Secretary

Otto Best (Nathan Mfg. Co.)
Treasurer

Discussion

The paper drew out a lively discussion which, however, dealt more with the various causes of failure, particularly of the cross compound pump, than the details of maintenance. One of the most frequently mentioned causes of failure was improper lubrication, there being set forth a diversity of opinions and methods for oiling the air cylinders of the cross compound compressors, but a general agreement that a satisfactory system of lubricating these cylinders has yet to be developed. One of the measures to be taken to avoid air pump failures and excessive maintenance is to give close attention to brake pipe leakage and in doing this not to overlook the brake cylinder.

The suitability of the orifice condemning test as a means of determining whether a pump is in condition for every class of service was questioned by several members, and was the subject of considerable discussion. The point was made that a pump which may just pass the condemning test may not be suitable for service on long, heavy trains in heavy grade territory. It was brought out in the discussion that the Interstate Commerce Commission condemning tests allow only about 10 per cent depreciation below the rated capacity of cross compound pumps, while the percentage is higher for other types and it was suggested that the degree of efficiency essential in any particular class of service should first be established and the test for that class of service modified to maintain that efficiency.

The members quite generally agreed with the author of this paper as to the desirability of tightening up generally on air compressor maintenance, one of the reasons that was particularly stressed being the damage done in service by failure of the brakes properly to release in cycling, this being frequently caused by the inability of a poorly maintained pump to raise the main reservoir pressure within the time allowed by the cycle, even though it may pass the condemning test.

TERMINAL TESTS OF AIR BRAKES

By W. P. Borland
Chief Bureau of Safety, Interstate Commerce Commission

There is no disposition on the part of the Interstate Commerce Commission at the present time to take extreme measures in its administration of the power brake provisions of the safety appliance law; but the time has arrived when better observance of the requirements of law by those who are responsible for the condition of air brake equipment may well be insisted upon.

The percentage of non-air cars now in service is so small as to be negligible. In air brake tests of 1,196 trains departing from terminals last year, comprising a total of 41,846 cars, inspectors of the Bureau of Safety found but 6 non-air cars. There is no longer any lack of available equipment, and any failure to comply with the requirements of law must be ascribed to neglect of the condition of equipment.

In the terminal tests above referred to our inspectors found 330 cars with brakes cut out and 1,947 cars with inoperative brakes. It is a matter of common knowledge that these terminal tests on departing trains do not correctly disclose actual operating conditions, for the reason that when the presence of a government inspector is known more than usual care and diligence are exercised in inspecting and testing brakes, as well as in setting out or repairing cars with defective brake equipment. As a result, reports of such tests are misleading and indicate better conditions and practices than actually exist.

In order to obtain a check upon the true condition of air brake equipment in general, tests of trains upon their arrival at terminals have also been made during the past year. In some instances the contrasts between the condition of arriving and departing trains are extreme and striking; for example, in one yard from which trains were departing with 100 per cent operative brakes, trains were arriving with as low as 56 per cent operative brakes. Of course it is as much a violation of law to haul a train into a terminal as away from a terminal with less than the specified minimum percentage of operative brakes or with associated power brakes not used and operated. The law states that it is unlawful to "run any train on its line" without the specified equipment.

The fact that prosecutions have not generally been filed in the past, except in cases where trains have departed from terminals with inadequate brake equipment, does not alter the requirements of law. In connection with these arriving tests, it should be noted that they serve merely to disclose cut out or inoperative brakes; in the reports of these tests there is nothing to indicate whether or not the brakes classed as operative are in effective and efficient condition. Statistics for the first year based upon these arriving tests will not be complete until July, but the results will be set forth in the next annual report of the Bureau, and will probably be published in detail in order to show the actual condition of air brake equipment in use.

It goes without saying that the terminal air brake tests conducted by the railroads, both arriving and departing, should be much more comprehensive and thorough than the inspections and tests made by the government inspectors. The tests made by the government inspectors are designed merely to indicate the general condition of air brake equipment for the purpose of ascertaining whether or not the law is being complied with. No specific method of conducting tests of this nature is prescribed; it is left to the individual inspector to secure the required information, and methods followed vary with locations and operating requirements, as well as with personnel.

It is not my purpose in this paper to enter into a discussion in detail of the methods which should be followed in conducting terminal tests. The results accomplished by these tests constitute the issue of paramount importance, and in each instance the results accomplished as reflected by the condition of air brake equipment should form the criterion by which effectiveness of methods in use is measured.

It is almost trite to say that inspections and tests should be made to ascertain whether all air brake parts and piping are in place, that foundation brake rigging is intact, and that all such apparatus is in operative condition. But it is frequently found in many parts of the country that the inspections and tests made are extremely superficial in character. It is not uncommon to find that no attention whatever is paid to broken retainer pipes or retainers missing or disconnected. Inspections have also indicated the necessity that more attention be devoted to the condition of foundation brake rigging. The need of better maintenance of this equipment is particularly apparent in view of the fact that the foundation brake rigging is an essential part of both the air brake and the hand brake equipment on a car and an inoperative hand brake is a penalty defect. It is the purpose of the Bureau of Safety in future to devote more attention to the condition of foundation brake rigging.

It hardly seems necessary to point out that tests made with yard-line pressure of 90 lb. when the train line pressure used is 70 lb., are not wholly desirable; nor that simply observing that the brake on the last car in a train applies and releases properly is not a proper test of the brake equipment of a departing train; but these conditions have been found to exist in large yards of important railroads.

It has been found that repair work was not being properly done. In one case in the middle west, one of the Bureau's inspectors made an air brake test on a train of 97 cars, in which the brakes on 17 cars were found inoperative, the majority of them being refrigerator cars. The triples on six of these cars bore stencil marks indicating that the triples had been cleaned within a month, but outward appearances led the inspector to believe that no work other than stencilling had been done on them. Subsequently an investigation was made at points where these triple valves had been stencilled and one triple valve was found newly stencilled that had not been cleaned; and on another newly stencilled car the dust collector was full of dirt and corrosion. In another case eight cars were found bearing stencil marks showing that brake cylinders and triples had been cleaned within the last three days. From outward appearances none of these cars had been worked on and three of them were taken down and examined. The brake cylinders and triples were found in a very dirty condition and the examination showed conclusively that no work had been done on them except stencilling. These conditions were traced to their source and corrective measures taken by officials in charge.

It is essential that air brake men be continually on the alert with a view of detecting and correcting improper maintenance and repair work resulting from ignorance, incompetence, lack of proper facilities, or slip-shod methods.

In many locations tests which are intended merely to show that brakes are operative are insufficient to meet operating requirements; it is essential not only to have operative brakes, but also to make certain that the equipment is in effective operating condition, including foundation brake rigging, brake cylinder, triple valve, retaining valve and all piping. Inoperative and ineffective brakes combined have resulted in numerous violations of the air brake law on mountain grades. There are a number of mountain grades in various parts of the country upon which it is common practice to control trains by means of hand brakes, holding the air brakes in reserve and using them only in case of necessity or emergency to supplement the hand brakes. On some grades no other practice has ever been followed. The attention of the commission has been called to the situations in which these unlawful practices exist at various times and

for various specific reasons. In one case an accident resulting from a portion of a train running away on one of these grades was investigated by the Bureau of Safety, and this investigation disclosed that one of the conditions leading up to this accident was the use of hand brakes for the purpose of controlling the train. Proper maintenance of present equipment is all that is required to permit trains to be handled safely on these grades by means of power brakes. And it is in the terminals through which these cars pass en route to these grades that the greater part of this maintenance work must be done. Excessive leakage and defective retainers were among the prevailing conditions which required considerable attention.

The order of the Commission of June 6, 1910, requires that not less than 85 per cent of the cars of a train shall have their brakes used and operated by the engineer of the locomotive drawing the train, and that "all power-brake cars in every such train which are associated together with the 85 per cent shall have their brakes so used and operated."

The minimum percentage requirement of this order is generally understood and recognized, and it is an infrequent occurrence that a train is hauled from a terminal having less than 85 per cent of the cars equipped with power brakes in operative condition. But in addition to the minimum percentage requirement specified, there is also a maximum requirement; the order reiterates the provision of law that all power-brake cars in a train which are associated together with the specified minimum percentage shall have their brakes used and operated. Comparatively little attention has been paid to this maximum requirement, and the belief is widespread and general that if a train has the prescribed minimum percentage of power-brake cars with air brakes in operation, the terms of the law are fully complied with. It is common practice for trains to leave terminals having cars with inoperative brakes, or having brakes cut out, notwithstanding the fact that facilities are available at such terminals for making repairs or replacements necessary to place all power brake equipment in proper operative condition.

Strict observance of the associated car provision of the law, as applied to trains leaving terminals or other points where facilities for making repairs are available, would result in 100 per cent operative power brakes in practically all trains leaving such points. The adoption of this practice would inevitably result in general and material improvement in air brake conditions; careful and thorough air brake tests at terminals would be required, and prompt attention would necessarily be given air brake repairs. The number of violations of the minimum percentage requirement would also be reduced, for the reason that trains now frequently leave terminals with barely 85 per cent of the cars having power brakes in operative condition, and if the brake equipment on additional cars becomes defective en route, or if cars with defective brakes are picked up, or if cars having operative brakes are set out, the train then has less than the minimum of 85 per cent required. This practice would also go far toward meeting the complaint frequently heard that air brake maintenance is neglected on roads where braking conditions are less severe than on roads having steep mountain grades, thereby imposing an excessive burden on the air brake inspection and repair forces of the latter roads.

If required to do so in order to bring about necessary air brake improvements, the Commission can adopt a different policy in the administration of the air brake law, and the existing minimum precentage required can be increased. But it is to be hoped that the railroads themselves are fully alive to the needs of the present situation and will voluntarily take such steps as may be necessary. Proper action by the Air Brake Association and active co-operation of all concerned with these matters will undoubtedly go far toward forestalling necessity for further action in the matter by the Commission.

LOCATION OF BRAKE PIPE ENDS AT THE LOCOMOTIVE PILOT*

By W. W. Wood
Chicago, Indianapolis & Louisville

At the pilot of a locomotive a situation exists in which the recommended practice, as it concerns brake-pipe ends, cannot be adhered to successfully.

The extended pilot, formerly standard everywhere, would not permit the diagonal cross-carrying of the coupled hose when connected with a car ahead or the rear of a leading locomotive, if the pipe end was on the left side of the drawbar. For that reason the pipe ends are commonly found to the right of the drawbar. Here is a condition that provides a brake pipe without lateral deflection from rear to front of locomotive.

But the locomotive builders having located the pipe end 26 in. away from the M. C. B. standard point for cars, have fixed its height from the rail and the distances from the center line of the drawbar shank and pulling face of the coupler knuckle, the same as provided for cars; this brought the terminal angle-fitting too close to the angle cock of the car ahead. Most railroad shops are following this practice.

The result on the Monon was that when the air was coupled to a car ahead, both hose of the connected pair would be crimped and the passage of air restricted. On a double-headed passenger train the air signal and brake equipment of each engine had been tested and found in good condition before leaving the roundhouse. The air piping of the second engine was exactly as it came from the builders and the pipe terminals on the tender of the forward engine were approximately M. C. B. standard in location. After coupling-up, both pairs of hose, brake and signal were crimped so flat that the air signal on the leading engine could not be operated from the cars but would respond to discharges from the pilot hose. The brakes on the cars would apply on a service reduction from the leading engine, but with emergency test from the leading engine, service application only was obtained on the cars.

Recommended practice now extends the brake-pipe ends on certain classes of freight cars much nearer the line of the pulling face of the coupler knuckle than formerly. Two modern, steel freight cars coupled together have their connected hose couplings carried at an angle of 90 deg. to the center line of the car so that they couple exactly crosswise. If such a car were coupled to the pilot of an engine having pipe ends as usually found, the condition should be considered absolutely impossible.

When this subject was brought up at the Central Air Brake Club, some members argued that with the modern receded pilot it would be possible to locate the brake-pipe ends at the left of the drawbar and follow the M. C. B. specifications as to location throughout. This will not hold good on all engines. On the Monon it has been found to be an easy matter to keep the pipe lines on the right of drawbar and obtain an ideal line-up of the hose when coupled forward.

Experimentally, we coupled a locomotive to the rear of a tender having standard pipe-end locations, detached the hose and angle fitting from the brake pipe at the pilot, connected its coupling with that of the tender and screwed a short piece of pipe into the other opening of the angle fitting to represent the brake pipe. Laying this piece of pipe directly on top of the pilot beam and placing its center 13 in. from the center line of the coupler shank, the ideal location was found. In practice we turn the angle fitting slightly toward the center of the track, about 20 deg. from a vertical line through the brake pipe. No attempt was made to standardize this location until we found that it would apply to every class of engine in service on the road.

*Submitted by the Western Air Brake Club.

This might not happen in all cases and the writer recommends that the car piping standards should be generally disregarded in the installation of pipe terminals at the pilot, and the proper locations at the right of the drawbar found for each class of engine.

Discussion

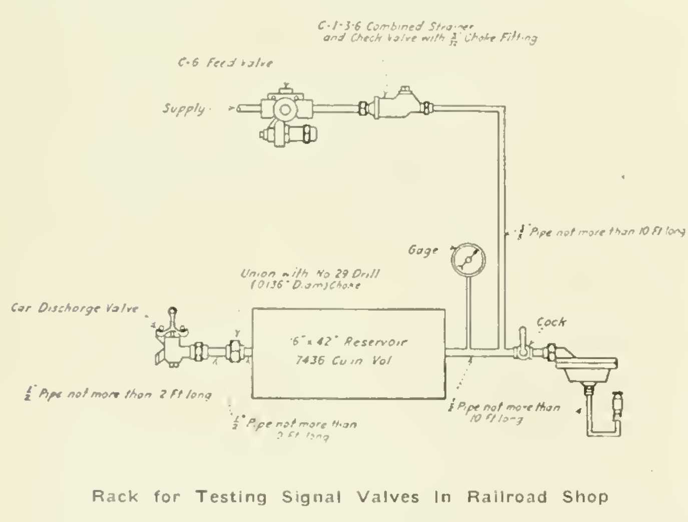
A number of variations in the location of angle cocks and brake pipe ends at the front ends of locomotives were brought out in the discussion. Much difficulty seems to have been encountered in arriving at a satisfactory location of the cut out cocks to meet the requirements of safety and, especially in passenger service, the convenience of the crew when doubleheading. The subject was referred to a committee for investigation and the drafting of a proposal for adoption as recommended practice for the location of brake pipe ends and the location and style of cocks to be used, at the next convention.

AIR SIGNAL VALVE MAINTENANCE*

By James Elder

From the writer's observation air signal valves have not been repaired and maintained as they should be, because air signals failed to respond from rear end cars or gave repeat signals. Where air signal valves are repaired so that they will pass the tests specified they will give good service for the entire period the locomotive is out of the back shop, with the possible exception of renewing the diaphragm. Thus the expensive practice of roundhouse men to keep tinkering with air signal apparatus would be greatly reduced. With the exception of changing a ruptured diaphragm, no other repairs to signal valves should be attempted in roundhouses or small shops. It is needless to say that a sufficient quantity of good repair or new signal valves should be obtained and be accessible for exchange purposes.

The important back shops should be supplied with suitable, inexpensive test racks, to represent the volume and



Rack for Testing Signal Valves In Railroad Shop

resistance of a 15-car passenger train, so that signal valves can be tested while locomotives are passing through the back shops, and no signal valve should be returned to any locomotive if it fails to pass the tests prescribed.

The greatest advantage will be gained by doing extensive repairs to signal valves at only the main shops. When signal valves are found worn or out of standard, and heavy repairs are required to put them in shape, and the valves cannot be repaired so they will pass satisfactorily, it will be to the advantage of the railway to send them to the manufacturer and have them restandardized.

Some of the troubles incident to poor operating signal valves are (a) worn fit of stem and guide bushing, (b) bearing fit of stem in bushing carelessly destroyed by inexperienced workmen, either reducing the stem bearing with a file or mashing it in a vise while holding it to remove the diaphragm, (c) removing the projection at the lower end of the stem by filing it away, (d) facing off the seat at the upper side of the lower cap nut, (e) the use of inflexible diaphragms other than those made especially for signal valves.

The drawing shows the testing device used on several western railways. Any signal valve passing this device can reasonably be expected to operate properly on long passenger trains.

A careful analysis shows that the fit of the stem in the bushing is required to be accurate; that if the stem is too loose the valve will repeat or not give any signal at all; whereas, if the stem is too tight a fit in the bushing, the signal will be too long or be too sensitive to light leakage reductions. The following procedure should be followed in testing the valves, the feed valve being set to maintain 45 lb. pressure and the check valve spring in the combined strainer and check valve reducing the pressure 3 lb.:

Test No. 1—With the whistle valve applied and the system fully charged, open the car discharge valve until the whistle sounds, and then quickly allow the discharge valve to close. As soon as whistle stops blowing quickly open the discharge valve again and so on, in this manner obtaining short blasts of the whistle in quick succession. Five distinct single blasts of the whistle should be obtained in 10 seconds, the time being measured from the instant of first opening the discharge valve, until the instant of opening it for the fifth time. Inability to obtain the five blasts within this time indicates excessive friction between the valve stem and bushing caused by a too close fit.

Test No. 2—With the system fully charged, hold the discharge valve open for 15 to 20 seconds continuously. This should produce one continuous blast of the whistle lasting until a few seconds after the discharge valve is allowed to close. If several short blasts of the whistle are obtained in the test, it indicates that the fit between the valve stem and bushing is too loose.

Discussion

The discussion indicated a general agreement with the author of the paper as to the inadvisability of making repairs to the signal valve in the roundhouse, most of those speaking even condemning the practice of changing diaphragms. The practice of many roads is to return the signal valve to the manufacturer for repair, but it was pointed out that because of the inability to have every valve taken care of in this way, the work done on those handled on the road was likely to suffer because of the lack of proper facilities for doing the work. The inference was that better results would be obtained if each road provided facilities at its principal shop for repairing these valves and handled them all at that point. The difficulty which in some cases has been experienced with rust which accumulates around the valve and its spindle and interferes with its satisfactory operation was mentioned. In the opinion of several members the best solution of this difficulty is to locate the signal valve at a point high enough in the cab to prevent the accumulation of moisture.

Air Consumption of Locomotive Auxiliaries

The committee reporting on this subject through wide investigation has determined that these devices are generally wasting much compressed air. A simple code of tests and condemning limits was proposed, the observance of which may be expected to result in materially improving conditions. An abstract of this report will be found on another page in this issue.

TERMINAL BRAKE WORK FROM THE REVENUE STANDPOINT*

By C. C. Ferguson

General Air Brake Instructor, Great Northern

The investment in all that constitutes a railway is earning just so long as cars are moving toward their destinations. When they are not, it is losing, because interest, wages and

*Submitted by the Central Air Brake Club.

*Submitted by the North-West Air Brake Club.

other necessary expenses are going on. This means that switching, testing air brakes, repairing and other work in terminals are losing revenue. Such delays are necessary, but it is plain that they should be kept as low as possible. The problem is now to test and make necessary repairs in the least time and with the minimum of switching.

Attention is directed to the instructions on Test and Repairs to Brakes on Cars in Terminal Yards, recently made recommended practice by the American Railroad Association, Section III-Mechanical. These instructions are as follows:

Incoming Trains

1. Freight cars in terminal yards should have the air brakes tested as follows:

2. Freight trains, on arrival at terminals where inspectors are stationed to make immediate brake inspection and repairs, shall have slack stretched and left with brakes fully applied in service application. Inspection of brakes should be made as soon thereafter as practicable and any needed repairs made, or promptly mark for repair tracks any cars that cannot otherwise be repaired.

Outgoing Trains and Yard Tests

3. While the train is being charged, make a visual inspection of retaining valves and retaining valve pipes, position of angle cocks and hose, and examine closely for leaks from the brake pipe and its connections, and make necessary repairs to reduce this leakage to a minimum when the brake system is charged to standard pressure.

4. When the brake is charged to standard pressure, make a 15-lb. service reduction, after which a second examination of the train should be made to determine:

(a) Brake pipe leakage.
(b) If triple valve will operate on service application.
(c) Piston travel.
(d) Brake cylinder leakage.
(e) If the brakes release properly.

5. If, during this test, the brake pipe leakage, as indicated by the brake pipe gage, exceeds 8 lb. per minute, it should be reduced to 8 lb., preferably 5 lb., and if piston travel is less than 6 in. or more than 8 in. it should be adjusted to 7 in. All defects found shall be repaired in the yard or car sent to shop or repair track for necessary attention.

6. In addition to the above terminal tests, at last terminal inspection point prior to descending mountain grades, it must be known that a sufficient number of retaining valves are in good operating condition to control the train.

The Incoming Test

Normally and properly the first thing done to an incoming freight train is to make the general inspection. Here we have dead time that, by means of incoming brake test, should be utilized to locate air brake defects so that such as are heavy may be marked for the repair tracks before switching is done and all available time employed for repairing the others.

But the time and a half for overtime since allowed to freight train men, and insufficient consideration given to certain features of the recommended practices warrant some changes in the foregoing.

Several of the roads represented in the North-West Air Brake Club have long since demonstrated the practicability and value of the incoming brake test. In fact, the Soo Line is undoubtedly the pioneer in making this test, with the Northern Pacific a close second. This is mentioned merely that due weight may be given to recommendations based on long experience. The first recommendation is that paragraph 2 in the foregoing be changed to read as follows:

2. The incoming air brake test should be made with all arriving freight trains and transfers, and to permit of this the incoming crews shall leave the brakes fully applied from standard pressure by a service reduction or reductions totaling 20 lb. Inspection of the brakes should be begun immediately and completed within 20 minutes, confining it to observance of piston travel, brakes that do not apply or that leak off and to other observable leakage, and quickly indicating defects found by suitable chalk marks. On completion of this inspection make indicated repairs or mark cars for the repair tracks, as the circumstances require.

The advantage of having the slack stretched while inspecting draft rigging and air hose is recognized, but to do this in an effective way will require, after the stop, releasing the air brakes, applying rear hand brakes, pulling out the slack, fully recharging and reapplying the air brakes, and an attempt to include it would increase the amount of overtime and would decrease the reliability of the incoming brake test.

The present reading of paragraph 2 discourages the incoming test, first, by the qualification, "where inspectors are stationed to make immediate inspection and repairs"; and, second, by stating that, following the application of the brakes, inspection "should be made as soon thereafter as practicable." This inspection is mainly to determine whether the brakes are reasonably efficient, and it will assuredly be granted that a brake which has not leaked off in 20 minutes will meet with this requirement. To appreciably extend this inspection time is unwarrantedly to delay traffic and increase expense, as it will send cars with reasonably efficient brakes to the repair tracks. The alternative is that inefficient brakes will not be detected.

Should it be desired to provide for the alternative of an incoming brake test being made by the slower and more cumbersome use of a yard testing plant, which we do not favor here, it should be cared for by a separate paragraph.

The recommended change in paragraph 2 refers to "standard pressure," understood for freight to mean 70 lb., and attention is called to the fact that if the test is made from a higher pressure it will pass some defective brakes as satisfactory because of the greater amount of auxiliary reservoir air to be leaked away. Hence, if any road is using a higher brake pipe pressure on any moving trains, it is recommended that it be reduced to 70 lb. (by applying and releasing) before making the test application.

The Outgoing Test

The haste more or less incident to the outgoing terminal brake test referred to in paragraph 4 will often result in the application being made before some brakes are fully charged. Hence, a reduction of 15 lb., with long trains, will result in some brakes failing to apply or hold long enough for the inspection which would be found satisfactory if they had been charged or if the reduction had been 20 lb.

The desire to combine with this test a fairly satisfactory measure of the rate of brake pipe leakage is appreciated and no recommendation for a change is made at this time.

Clause (e) is a detail which cannot be determined while brakes are applied, as here stipulated. While the object will doubtless be generally understood, the wording of this paragraph could advantageously be changed to make the meaning clearer.

R. H. Aishton's circular 95 of January 8, 1920, dealing particularly with avoiding delays at terminals, in order to lessen time and a half for overtime, suggests for each important yard the need of a yard plant for testing the outgoing train before the engine is applied. This is approved, but with the distinct understanding that it cannot accomplish the needed results unless the incoming test is made; also, that to realize its value sufficient inspectors must be available who must receive prompt notice when a train is ready for them, so as to avoid wasting time waiting for it to be made up or being late because of not knowing it was ready for them. This is not the time nor the place to make other than the lightest repairs, mainly stopping brake pipe leaks. In fact, if the incoming test and indicated repairs have been made as they should be and if inspectors are promptly advised when each train is made up, the character of the remaining work, including the outgoing terminal brake test, will usually be such as to enable the despatcher to figure quite accurately as to when a train will be ready. The outgoing crew would then find the train tested and charged and requiring no more brake work on their part than making the brake pipe test from the engine immediately after attaching it. If operating departments really propose to provide and make use of outgoing yard brake charging and testing plants, it would be well to add to the recommended practice instructions to cover their use.

As the detailed instructions governing the making of the incoming brake test can largely influence the results obtained we submit the following as in effect on one large road: "Enginemen and trainmen of freight trains on arrival at terminals will leave the brakes applied by a 20 pound service reduction made from 70 pounds. Where

engineman has made an automatic application for stopping he will as soon as stopped, add to it by one farther, continuous reduction sufficient to make a total of 20 pounds, and watching the gage, insure that this amount is had when the brake valve discharge ceases. On its completion he will give one short whistle blast as advice to brakeman that he may cut off and to inspectors that inspection may begin. The brakeman will not close angle cocks until this signal is given.

"When the train must be left on two or more tracks, or when crossings must be cut, those concerned will follow the foregoing plan before cutting off each part.

"To avoid preventing inspectors from ascertaining the condition of air brakes, switchmen, carmen and others must not discharge any air from the auxiliary reservoirs or brake pipe of cars that have not been inspected. Before discharging any air from those already inspected an angle cock must be closed between such and any uninspected brakes.

"On brakes being applied, as indicated by whistle signal, inspectors will at once and rapidly examine for piston travel, brakes failing to apply, any that have leaked off and brake pipe leaks. At this time, make no repairs; merely indicate the defects with chalk. After completing inspection repair the defects that should be cared for in the yard. For other defects bad-order cars for repair tracks, unless impracticable, as may be with time freight. The air brake and the general inspection must not be made by the same man or men.

"Adjust incorrect piston travel (less than 6 inches or over 8 inches) to 7 inches. Consider cars over 12 months since brakes were cleaned as having defective brakes. Loads that cannot be held for brake repairs earlier will, where destination is a terminal, be marked on arrival "BO when empty," with date, and defect. These will be delivered to repair tracks as soon as practicable after unloading."

Discussion

The discussion covered the whole field of freight brake conditions, which all have a bearing on the difficulties of getting trains out of terminals with brakes in condition to meet the requirements of the safety appliance law without excessive terminal delays. The discussion indicated clearly that freight brakes generally are in an unsatisfactory condition from the service standpoint and that this condition is not due to any one cause, but to a large number of causes. Some of the causes mentioned were undesired emergency brake applications, excessive brake pipe leakage, careless and unskilled workmanship in maintenance, neglect of maintenance, inadequacy of the customary type of attachment for brake cylinders and auxiliary reservoirs, retention in service of worn-out brake cylinders in which tight packing leathers are an impossibility and a lack of appreciation and indifference of the managements to the resulting loss in operating efficiency. That a high standard of brake maintenance is not only possible but practicable was indicated by the experience of several roads operating with a high percentage of their own equipment which is retained and maintained at home. Several instances were given where railroads regularly send trains, in some cases with as many as 90 to 100 cars, from terminals with not more than two or three pounds per minute brake pipe leakage, and one instance was mentioned where such a train, departing from the initial terminal with a leakage not to exceed three pounds per minute, arrived at the end of a 125-mile run and when tested showed but four pounds per minute brake pipe leakage.

That when once placed in good condition, the maintenance of a high standard of freight brake conditions is not a difficult matter was evidenced by the experience of the Duluth, Missabe & Northern, which was mentioned several times by members from other roads as having exceptionally good brake conditions. With a total of 7,000 cars in regular freight service on this line, it was necessary to set out on account of brake conditions but four cars in a period of twelve months, and these were due to leaky cylinder packing leather caused by over travel of the piston in connection with a failure of the foundation brake gear. From an initial brake cylinder leakage of three pounds per minute, 2,000 cars after 24 months' service without cleaning had developed cylinder leakage not exceeding four pounds per minute maximum. Other roads reported as high as from 10 to 20 per cent of the brakes tested requiring recleaning in from one to three months following the last cleaning date.

The inability of the Air Brake Association alone to remedy these conditions because of the possible terminal delays and initial expense required to bring about a countrywide improvement of these conditions, was touched on several times. The value of the incoming test in this connection was dwelt upon because of the possibility of reducing terminal delays chargeable to brakes by utilizing the dead time during the general inspection of the train to make needed repairs. A significant point was brought out in connection with the establishment of the incoming test on one road where it has been in effect for a number of years. Some difficulty had been experienced in convincing the management of the desirability of the test, as the time available resulted in doing much more work than is usually permissible following the outgoing test. It was found, however, that an appreciable credit balance resulted from the charges against other roads for the extra amount of work done, and the presentation of this fact to the management secured approval for the establishment of the incoming brake test.

The convention voted to refer the subject to a committee with instructions to investigate general conditions, formulate recommendations and present data as to possible savings from a revenue standpoint from the establishment in practice of the recommendations.

Other Papers and Addresses

The St. Louis Air Brake Club submitted a report on "Changes in the H-6 Brake Valve," signed by W. H. Davies, R. E. Wark, and F. V. Johnson, which outlined a method of making the changes in existing brake valves that are now incorporated by the manufacturer in new valves. An illustrated lecture on "Modern Trains and the U. C. Equipment," by J. C. McCune, was submitted by the Manhattan Air Brake Club.

During the course of the convention, the association was addressed briefly by W. H. Winterrowd, chief mechanical engineer of the Canadian Pacific, and F. W. Brazier, assistant to the general superintendent of rolling stock, New York Central. R. I. Cunningham of the Westinghouse Air Brake Company, gave a very interesting talk on air brake conditions in France.

Business

An invitation from the American Railroad Association, Section III-Mechanical, to affiliate as a division of that organization was brought before the association and referred to a committee, which drafted a tentative set of by-laws designed to protect the interests of the association membership as it is now organized, in the event of affiliation. The matter was finally referred to the executive committee with instructions to conduct negotiations with Section III-Mechanical and report to the association at the next convention for action by the members.

The following officers were elected for the ensuing year: President, L. P. Streeter (Illinois Central); first vice-president, Mark Purcell (Northern Pacific); second vice-president, George H. Wood (A. T. & S. F.); third vice-president, E. M. Kidd (Norfolk & Western); secretary, F. M. Nellis (Westinghouse Air Brake Company); treasurer, Otto Best (Nathan Manufacturing Company). W. W. White (Michigan Central) was elected a member of the executive committee to fill the vacancy created by Mr. Kidd's election as third vice-president.

View of Inspection Shed and Accumulated Car Wheels

Economies Possible by Car Wheel Grinding

The Field for Effective Car Wheel Grinding Includes New and Old Cast Iron and Steel Wheels

WHILE an exhaustive study of car wheel grinding is impossible within the limits of this article, certain convincing data are presented which proves the possibilities of the practice. Not only have cast iron wheels with slid flat spots been reclaimed by grinding, but important railroads in different parts of the country have found it profitable to grind the treads of new cast iron and cast steel wheels, these being used in light passenger service and under light weight box cars, refrigerators and caboose cars.

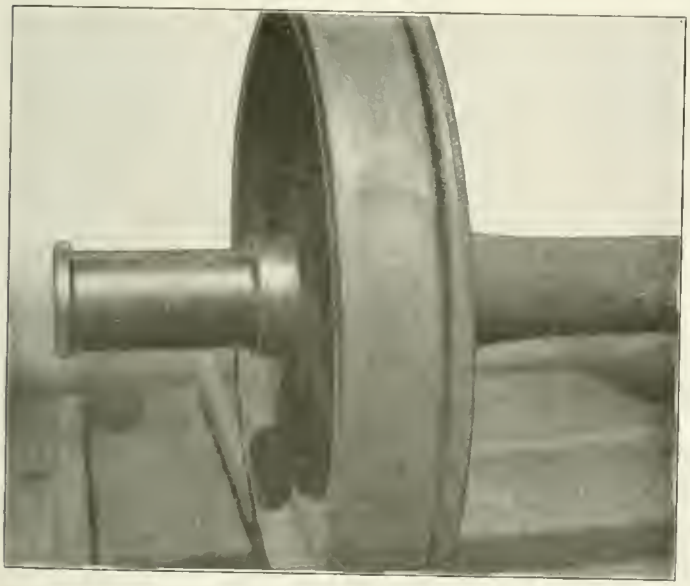


Fig. 1—Type of Flat Spot Removable By Grinding

Besides the need for a more general installation of car wheel grinders in railway shops, it is apparent that those machines already installed should be used to their utmost capacity. In fact, the crux of the matter lies right there. With a net profit of $6.05 on every pair of cast iron wheels reclaimed by grinding, any railway shop can afford the installation of a grinding machine, provided enough slid flat wheels come to that point to keep the machine busy eight hours a day. In case enough slid flat wheels are not available, the machine can be kept busy grinding new wheels.

The car wheel grinding practice most commonly known consists of grinding flat spots out of chilled cast iron car wheel treads. Obviously, the thickness of chill is greater on a new wheel than on one with a heavy mileage, and the length of flat spot that can be ground out without getting through the chill is, therefore, relatively greater. The minimum depth of chill at the middle of the tread of a good quality wheel is ½ in. and, while common practice limits the length of flat spots removable by grinding to 3½ in., some authorities maintain that this limit should be increased to 4 in. or 5 in. On a 33-in. wheel, 3½-in. and 5-in. flat spots represent depressions of .095 in. and .190 in., respectively, which leaves a considerable depth of chill after grinding. The kind of flat spot removable by grinding is shown in Fig. 1, while Fig. 2 shows a pair of wheels after being ground.

In addition to reclaiming cast iron wheels with flat spots, it has proved desirable to grind cast iron passenger car wheels when newly applied and before being put into service. One of the leading railroads in the east has followed this practice for a considerable period of time and finds that when the tread of a wheel is once ground smooth, round and concentric with the journal, there is a material increase in the actual ton mileage. In addition, flange wear is reduced to a minimum by having true wheels of equal diameter on the same axle. For suburban passenger service especially, ground wheels are desirable because the treads are then concentric with the journals, and the whirring sound due to raised chill marks is eliminated.

While most roads turn their wrought steel tired wheels, grinding presents a possibility of saving service metal because it is not necessary to take a heavy cut to get under the hard skin on the treads. The controlling feature as to grinding or turning wrought steel wheels with flat spots is

the condition of wear of the flanges. With the cast steel wheel, however, especially one with a high proportion of manganese in the tread, the car wheel grinding machine affords the only means of securing a smooth wheel tread without eccentricity.

An example of the type of machine developed for car wheel grinding is illustrated in Fig. 3. It can be used to grind car wheels up to 44 in. in diameter, and engine truck wheels up to 36 in. in diameter. Since the wheels are ground without being removed from the axle, the machine is designed for standard 4-ft. 8½-in. gage, and cannot be changed for other gages. Two grinding wheels of 24-in. diameter and 2¾-in. face are used with the machine, and are adapted to grind either steel or chilled cast iron wheels. Driven by a 35-hp. constant speed motor, the machine has ample power to remove metal quickly, and the production is materially increased by a pump and water tank arrangement, furnishing 40 gallons of water per minute on grinding wheel.

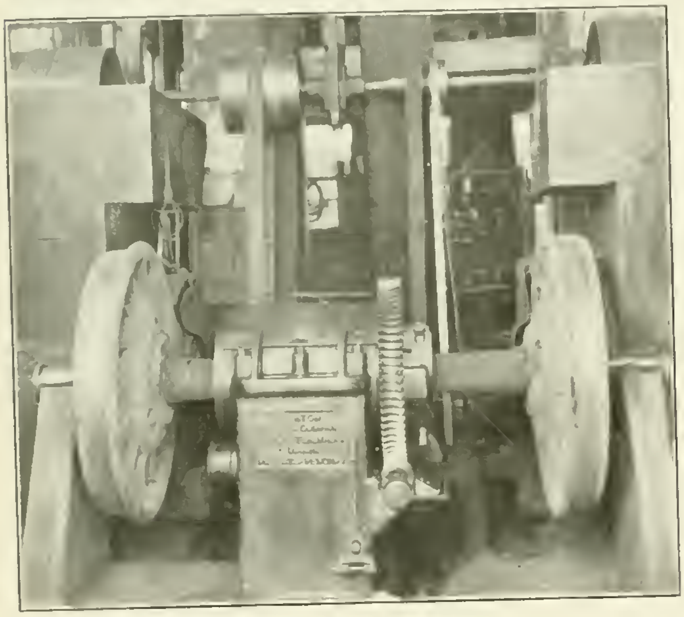


Fig. 2—Car Wheels Just After Being Ground

Chilled Cast Iron Wheels

The number of chilled cast iron car wheels reclaimed by grinding at any one point varies greatly from time to time and with the season of the year. For example, it has been noticed that much more slipping, with resultant flat spots, occurs during the winter months than during any other time of the year. The number of flat spots developed during the spring and summer months, however, is large. In March of the present year, 1,200 cast iron wheels were sent to the scrap dock of the eastern railroad previously referred to, and 10 per cent of these were reclaimed by grinding. It is felt that many shops not now equipped with car wheel grinding machines are unable to take advantage of a large possible saving. While interchange rules do not provide for the removal of wheels with flat spots under 2½ in. long, a large number of flat spots over that length develop. In addition, a careful inspection of the scrap pile indicates that inspectors are condemning many wheels that could be reclaimed by grinding.

Table 1—Time Required to Grind Flat Spots Out of Chilled Cast Iron Car Wheels

Car wheel, pair, No.	Time of set up, minutes	Grinding time, minutes	Total, minutes
1	10	30	40
2	10	39	49
3	10	17	27
4	10	27	37
5	10	25	35
6	10	40	50
7	10	15	25
8	10	28	38
9	10	25	35
10	10	16	26
11	10	26	36
12	10	21	31
13	10	24	34
14	10	34	44
15	10	30	40
16	10	38	48
17	10	16	26
18	10	42	52
19	10	14	24
20	10	45	55
21	10	24	34
22	10	17	27
23	10	30	40
24	10	18	28
25	10	16	26
26	10	50	60
27	10	35	45
28	10	37	47
29	10	30	40
30	10	40	50

Average time = 38 minutes

To estimate the actual saving effected by grinding out the flat spots in chilled iron car wheels, the data shown in Table 1 were obtained in a trial test. The average time of setting up the pair of wheels in the grinder was 10 minutes, and the grinding time varied from about 14 to 50 minutes, depending upon the condition of the wheel tread and the length of the flat spot. As indicated, the average total time required to grind each of 22 pairs of wheels was 38 minutes.

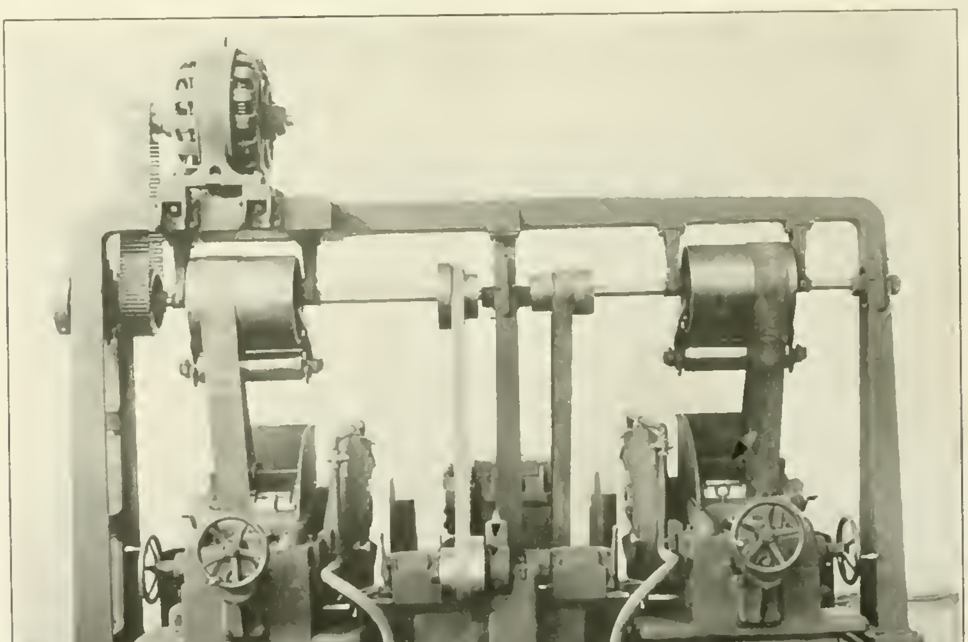


Fig. 3—Machine Developed for Grinding Mounted Car Wheels

The saving effected, as shown in Table II, was computed by obtaining the difference between what it would cost to apply a new wheel and the cost of grinding flat spots out of the old one. It is obvious that the cost, in the case of a new wheel with a newly developed flat spot, includes the difference between its new and scrap value, plus the cost of removing, boring and applying the new wheel. This total figure is $7.55, as indicated. Most manufacturers offer a differential of $1.05 per hundred pounds, but in the present calculations the M.C.B. differential of $7.25 for a 33-in. wheel is used. The labor charges represent a relatively small proportion of the total, and the total figure is conservative, because of the assumption that only one wheel develops a flat spot, whereas the more common experience is to find a flat spot on both wheels mounted on the same axle. The saving will of course vary with the probable service life of the wheel depending on the amount of tread or flange wear existing at the time the flat spot develops.

Table II—Saving Effected by Grinding Flat Spots Out of Chilled Cast Iron Car Wheels

Cost of applying new wheel:		
M. C. B. differential on 33-inch wheel	$7.25	
Charge for removing old wheel	.09	
Charge for boring new wheel	.12	
Charge for pressing on new wheel	.09	
Total		$7.55
Cost of grinding out flat spots:		
Labor per pair, at .72 an hour	$0.46	
Power per pair, at .02 a kw. hour	.28	
Grinding wheels, per pair	.15	
Interest at 6 per cent	.23	
Depreciation and repairs at 10 per cent	.38	
Total		1.50
Total saving per pair		$6.05

The first item to consider in the cost of grinding out flat spots is the labor charge. As shown in Table I, the average time required for grinding, including the time necessary to place the car wheels in the machinne, is 38 minutes. In most shops the man who operates this types of machine receives 72 cents an hour, which, for a period of 38 minutes, is 46 cents. It is estimated that the machine at normal load consumes about 30 kw. at a rate of two cents a kw. hour, but the power is not on during the time of setting up. Therefore, the total cost of power per pair of wheels is:

$$30 \times \frac{38 - 10}{60} \times 2 \text{ cents, or 28 cents per pair.}$$

A very important item in operating efficiency is the selection of a suitable grinding wheel. It is possible that a certain grinding wheel can be chosen, which will grind as many as 800 wheels, but the results both as to production and quality of work are not nearly as satisfactory as when a softer grade of wheel, which will grind possibly 200 wheels, is used. If grinding wheels cost practically $30 a piece and last to grind 200 wheels, the cost of grinding wheels per pair of car wheels ground is 15 cents, as shown.

Table III—Time Required to True up New Cast Iron Wheels by Grinding

Car wheel, pair, No.	Time of set up, minutes	Grinding time, minutes	Total, minutes
1	10	10	20
2	10	8	18
3	10	8	18
4	10	8	18
5	10	8	18
6	10	10	20
7	10	9	19
8	10	7	17
9	10	10	20
10	10	10	20
11	10	10	20
12	10	8	18
13	10	10	20
14	10	9	19
15	10	8	18
16	10	7	17
17	10	9	19
18	10	10	20
19	10	9	19
20	10	10	20
21	10	9	19
22	10	8	18

Average = 19 minutes

Interest charges at six per cent per annum on an investment of $15,000 (the cost of the machine) amount to 23 cents per pair of wheels. This figure is obtained by assuming an eight-hour day, and a time of grinding of 38 minutes. It is obvious that a high priced machine must be kept busy as much as possible to reduce the overhead charges, and in shops which are working two shifts, the interest charge on the investment is reduced one-half.

The depreciation and repair charges, shown in Table II, are estimated on a 10 per cent per annum basis and amount to 38 cents per pair of wheels. The total cost of grinding, then, amounts to $1.50 per pair of wheels. This cost is nearly three times as great as that computed on page 406 of the 1917 volume of the *Railway Mechanical Engineer*. Attention is called to the relatively large proportion of the charges for interest and depreciation, elements which are too often neglected in estimated savings. With the present cost of modern up-to-date machinery, these items must be carefully considered and every effort made to use the machines to their utmost capacity; otherwise, it is impossible to show a net profit in operation. Inasmuch as the cost of shipping flat wheels to the grinder will about equal the cost of shipping new wheels, the total saving for each new wheel is $6.05, as shown in Table II, and the only requirement necessary to make a car wheel grinder earn a profit is to see that sufficient wheels are received to keep the grinder busy eight hours a day.

New Cast Iron Wheels

The idea of grinding new cast iron passenger car wheels on the tread to insure the treads being accurately round and concentric with the journals, has been tried and proved good practice. When new wheels are ground in this way, there is an error not exceeding .002 in. or .003 in. from a perfect circle, and this insures a smooth riding wheel on which the brake shoe is not likely to stick. The grinding times on a lot of 22 new chilled cast iron passenger car wheels are shown in Table III. As in the previous tests, the time of set-up is estimated at ten minutes and the total average time of grinding is nineteen minutes.

Table IV—Data Secured in Grinding New Cast Steel Car Wheels

Diameter of grinding wheel, inches	Car wheel size, inches	Depth of cut, inches	Net grinding time, minutes
23¾	33	....	14.50
	33	....	8.66
	33	....	7.16
	33	....	7.00
	36	....	9.31
	36	....	10.32
	36	.080	.....
	36	.065	13.00
	36	.031	9.24
	36	.028	7.66
	33	.068	6.00
	33	.051	8.00
22	33	.056	7.32
19 3/16	36	.118	9.16
	36	.032	11.00
	36	.090	6.32
	36	.110	8.00
	33	.090	15.00
	33	.045	9.32
	36	.150	11.50
	36	.043	5.16
	36	.085	5.50
	36	.041	4.00
	36	.070	2.32
17¼	36	....	11.50

Average time = 8.62 minutes

Inasmuch as the benefits of grinding new car wheels are nearly all indirect, there is no good method of estimating the saving, but several important roads have given the practice a thorough try-out and found it economical in the long run and satisfactory. Thus far very little grinding of car wheels, except in the passenger department, has been done.

New Cast Steel Car Wheels

In the grinding of steel car wheels, new factors enter into consideration. For example, steel tired wheels can probably be placed in a wheel lathe and turned at a cost not much greater and in no longer time than would be required to grind the wheel treads. A new flange contour would be obtained but at the expense of service metal since a grinding machine does not need to cut under the hard surface skin on the tread. With the cast steel car wheel, however, especially one having a manganese tread, the pendulum again swings in favor of the car wheel grinding machine as a method af truing the wheel tread and making it both round and concentric with the journal. Attention is called to Table IV, which shows the data secured in grinding 25 pairs of steel wheels. The average grinding time was 8.62 minutes, which, added to 10 minutes, the time of set-up, gives a total time of 18.62 minutes. In other words, there is little difference in the length of time required to grind either the cast iron or cast steel car wheel. Additional information secured in this test shows the reduction in grinding wheel diameter as the work progressed, also the depth of cut which varies from .043 in. to .150 in.

Conclusion

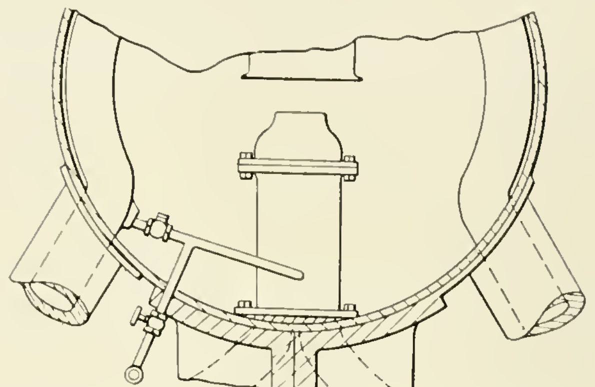
To summarize the results of tests mentioned in this article and the experience of important roads in different parts of the country, it has been demonstrated good practice to reclaim cast iron car wheels with flat spots up to 3½ in. long, provided the wheel has not made too great a mileage. The economy of the practice also depends on finding enough wheels to keep the grinder busy the full working day. Twenty-four pairs of new cast iron passenger car wheels can be ground in an eight-hour day and actual experience has demonstrated that these wheels should unquestionably be ground before use to insure a round, smooth tread, concentric with the journal. Extension of the grinding practice to new freight car wheels depends on whether the decreased flange wear, due to heavy wheels of equal diameter, would make it pay to grind mated wheels of the same taper size. That it is possible to grind steel car wheels, has been demonstrated beyond a question of doubt, but in actual practice it is probable that the grinding method can be more profitably used in the case of a cast steel wheel rather than a wheel with wrought steel tires. The manifest advantages of grinding car wheels in general have been appreciated and taken advantage of by leading trunk line railroads, and it is reasonable to believe that many smaller roads could benefit by the practice.

EXHAUST PIPE VALVE

Some months ago the Ann Arbor Railroad put into use an exhaust pipe actuated by fluid pressure, as shown in the illustration, and at the present time this railroad is having two locomotives built by the American Locomotive Company at their Dunkirk works that will be equipped with exhaust pipes of this design.

By referring to the illustrations of this device it will be seen that when the throttle valve is open steam is supplied to the connection, furnishing pressure required for the operation of the exhaust pipe valve. When vacuum relief valves are used air is admitted to the cylinder in the usual way, and no gases or cinders are drawn into the valve chamber from the smoke box. When vacuum relief valves are not used, and while the reverse lever is in the direction of movement of the locomotive, the cylinders are converted into vacuum pumps, which action works as a vacuum brake tending to retard the movement of the locomotive.

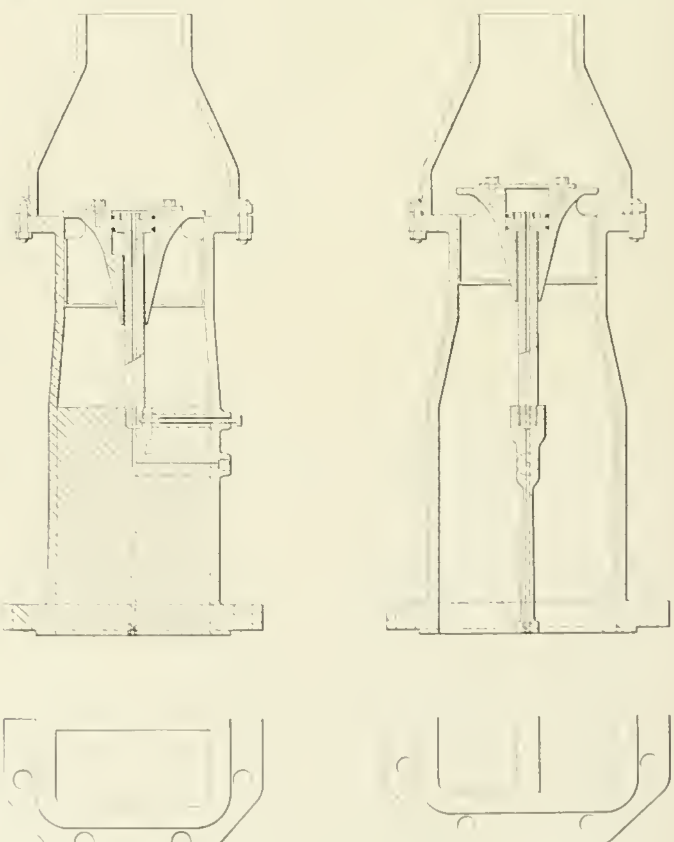
When relief valves are used and the reverse lever is placed in the opposite direction to the movement of the locomotive, the cylinders act as air compressors and the air reservoir may be charged automatically with compressed air without the possibility of drawing any fine particles from the smoke box that might be considered detrimental to the air-brake mechanism. If the locomotive is handled dead in a train a separate connection is provided to the passage leading to the exhaust pipe valve, which may be connected to the brake system so that when charged the exhaust valve will be held off its seat



Arrangement of Pipe Connecting to Exhaust Stand

and the locomotive may be moved in either direction without difficulty.

This exhaust pipe valve is the invention of J. E. Osmer, superintendent motive power of the Ann Arbor Railroad, who has applied for patents covering the device. It is claimed that its use will result in a considerable saving in valve oil



Exhaust Stand With Valve

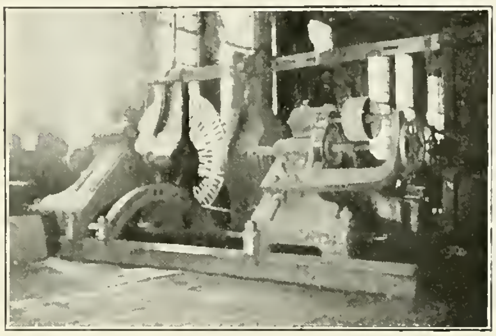
and a reduction in wear on valve rings, cylinder packing, piston rod packing and valve chamber bushings.

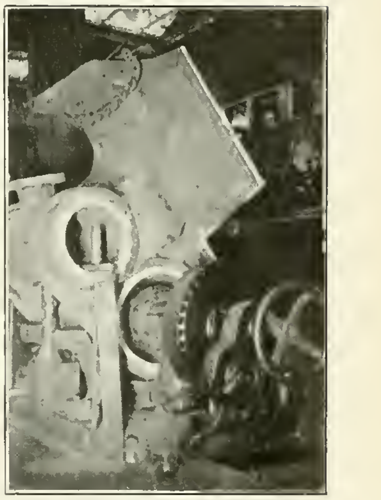
It is further stated that this exhaust pipe valve is particularly applicable to locomotives operating over heavy grades, where they are required to drift for long periods, causing the steam passages to become clogged with carbon and particles from the smoke box.

Railroads Need Modern Machine Tools

More Critical and Scientific Attention Must Be Given to the Upkeep of Cars and Locomotives

BY ROY V. WRIGHT
Editor, Railway Mechanical Engineer





Nobody Knows How Old They Are

THERE is no question about the seriousness of the transportation problem. Production is today greatly restricted because of the lack of adequate transportation facilities, coupled with the fact that the existing equipment is not being used with the greatest possible efficiency.

There are very good reasons for the situation in which the railroads now find themselves. In the first place, for the early part of the year up to the time of the outlaw strike, the roads handled more traffic than ever before in a corresponding period. More traffic is being offered to them now than ever before. In the second place, the roads found it necessary during the war to work their facilities and equipment to the very limit, and because of this and the lack of labor and material they naturally were unable to maintain their properties in the best condition. In the third place, there was very great uncertainty until the last moment as to just when the roads would be handed back to their owners and under what conditions. It was, therefore, of course, impossible for the managements to make the necessary contracts for the new equipment and facilities which are so greatly needed at this time. Indeed, even today they are more or less at sea as to how to finance themselves except for a few of the more prosperous roads. The Pennsylvania, with its splendid property, had to pay 7½ per cent on its $50,000,000 bond issue, and yet this sum covers only a small part of its needs. Congress has provided a revolving fund which is not at all adequate so far as meeting the present needs of the railroads is concerned, and which cannot be made use of by the weaker roads because they are unable to furnish the right kind of security.

Fortunately, Congress and the public at large are thoroughly aware of the necessity of restoring the credit of the roads so that they will be in a position to finance themselves in the future. The extent to which credit will finally be restored will depend upon how fully the enlarged and reorganized Interstate Commerce Commission will discharge its responsibilities in seeing that the roads are given adequate rates and that the Transportation Act is interpreted in such a way as to develop rather than restrict the activities of the roads.

Even those roads which have ordered equipment are being embarrassed because they went into the market so late that the other industries beat them to it, and in many instances they will have difficulty in getting early deliveries unless some sort of priority arrangements can be agreed upon. What good will it do the industries if they secure material which is needed by the railroads, and which, if assigned to the railroads, would enable them to increase their capacity so that they could handle a larger part of the output of the industries.

So much for the problem in the large.

Better Use of the Equipment

There are many ways in which better use can be made of the equipment and facilities which the railroads now have. Shippers can cooperate to a very much greater extent than they are now doing in the prompt loading and unloading of cars. Splendid cooperation was given during the war, but since the signing of the armistice much less interest has been taken by many of the shippers. It is now more than ever necessary that the cars be loaded to their full capacity and that they be loaded and unloaded as quickly as possible. The Interstate Commerce Commission will undoubtedly take steps to inaugurate practices which will be helpful in this direction, but it will also be necessary to secure and retain the hearty and cordial interest of the shippers.

The railroad managements must do their full part in getting better use from the facilities and in increasing the efficiency of operation. With the present labor conditions this will be a most difficult task. The men believe that they have not been treated rightly as to compensation, and are more or less impatient with what they believe to be the slow progress on the part of the Labor Board which was provided by the Transportation Act. Naturally they are not doing their best work. On the other hand, they must undoubtedly be awakening gradually to a realization of the fact that the slackening up of their efforts is an economic waste, and that it is forcing living costs higher and higher. The managements must not only win them over and get them to see the problem in the right light as related to the good of the country as a whole (and therefore themselves), but they must adopt an aggressive program to train and develop the new and inefficient men that they have had to employ to replace those skilled men that have been taken away from them by the industries which could afford, or felt they could afford, to pay much more for the services of these men than could the railroads.

*An address before the National Machine Tool Builders' Association at Atlantic City, N. J., May 20, 1920.

Cars and Locomotives Must Be Kept Fit

Railroad managements learned a most severe lesson when they tried to handle the tremendous increase in traffic after our country entered the war. They learned that no road could work efficiently or anywhere near its capacity unless the cars and locomotives were maintained in first-class operating condition. Under-maintenance and weak equipment mean breakdowns on the road, delays to traffic, damage to freight, and abnormal increases in the cost of operation. The thing that today is necessary more than anything else is that the roads should concentrate upon the care and maintenance of their cars and locomotives in order to get the very best possible returns from such labor and the small amount of money which is now available. This means that the weak spots must be located and strengthened one by one in order that the effectiveness of the transportation machine as a whole may be developed to the highest possible point.

Here is where we get down to the necessity of making a most critical analysis of the machine tools and equipment in all of the shops and engine houses on every road. The financial resources of the roads at this time are such that it will be foolish and ridiculous to expend in a haphazard way any money for equipment or facilities. Every cent must be scientifically placed where it will do the greatest possible amount of good.

What Machine Tools Are Needed Today?

It is impossible to make any accurate general statement as to the present condition of the machine tools on the railroads. With the assistance of the Railroad Administration, some of the roads on which conditions were particularly bad during the war were enabled to add a considerable number of new tools; other roads whose needs were not so pressing have had to discontinue their regular programs of improvement and their equipment is today considerably below what would have been its normal condition had it not been for the war.

Frank McManamy, assistant director, division of operation, United States Railroad Administration, in speaking before the New England Railroad Club six months before the end of government control said: "The use of out-of-date tools and machinery in railroad shops—although never satisfactory—may have been in the interests of economy at the rates paid for labor before the war, but under the rates now paid the use of inefficient machinery is not only unsatisfactory but decidedly expensive. I shall not specifically refer to conditions in the different shops at the time the railroads were taken over by the government, but it is a quite well-known fact that many of them, together with their equipment, were at that time and are today almost hopelessly out of date in the matter of buildings and equipment, and that the methods which this lack of facilities make necessary are such that no manufacturing industry operated on a competitive basis could exist under. In fact, it has been stated, and with considerable justice, that \$10,000,000 spent for shops and shop machinery prior to 1917 would have made it unnecessary for the government to have assumed control of the railroads. Whether or not this statement is true, it is a fact that one of the principal reasons—if not the principal reason—for taking over the railroads was the condition of locomotives and cars in certain sections of the country which, together with insufficient terminal facilities and the effort of many shippers to use the cars as storehouses, caused such a congestion that nothing short of centralized control with complete authority could have met the situation."

Some railway mechanical departments have always had a keen appreciation of the value of keeping the machine tool and other shop facilities up-to-date and in first-class condition, and have been able to secure the approval of their managements to such programs. Other roads, because of financial conditions or lack of vision on the part of their managements, or a combination of both of these factors, have struggled along with old inadequate equipment, and whether they realize it or not have had to pay a mighty high price for so doing.

I know of one important road which has always given careful attention to its machine tools and has replaced old tools or added to the equipment whenever it appeared to be wise to do so. This road has the reputation of maintaining its cars and locomotives in the best possible condition, and such statistics as are available would appear to justify this course by the lower cost of operation and the better use which is being obtained from the equipment. On the other hand, I know of another large road which has purchased practically no machine tools for ten years. There are not a few shops in the country that have a large number of tools which can best be described by the use of the words "ancient" or "antique."

In general it is safe to say that there are very few roads that are not today in need of a considerable number of new tools, while many of the roads ought, in the interests of efficiency, to make very heavy expenditures for machine tools and shop equipment. The *Railway Age* in an article in its January 2, 1920, issue showed as a result of an extensive and careful study that to provide for the normal growth of the railroads and to bring the equipment into proper shape at least \$54,000,000 should be expended for shop machinery and tools within the next three years.

Selection of New Tools

Too large a percentage of the railway mechanical departments have in the past failed to make any thorough or scientific analysis as a basis upon which to order their shop tools and equipment. It is true that a number of them have had experts in charge of the machine tool and shop equipment, but even in equipping new shops no attempt, except in a very few isolated cases, has been made to make a thorough and detailed analysis of all of the requirements. The late L. R. Pomeroy showed how this should be done in a study which he made in connection with the equipment of the Scranton, Pa., shops of the Delaware, Lackawanna & Western. This included a listing of each operation for each piece of work in order to build four new Consolidation locomotives each month, and to make eight light repairs and thirty general repairs. The analysis included the number of pieces of each class of work which would have to be performed each month, the type and size of machine tool required for each operation, together with the average time per piece and the total days' work per month for each type of machine tool. This study, which included the machine shop and boiler shop, covered several hundred different operations, and by means of it it was possible to decide just what kind and exactly how many tools should be installed.

There are those who strenuously object to tackling the problem in this way because they insist that locomotive and car repair work differs materially from the manufacture of new work and that the repair of each locomotive presents a different combination of operations. This argument has been worked overtime and railway shop managements have got to get down to brass tacks and recognize that in dealing with the law of averages they can approximate very closely the demands that will be made on the shop each day or week. It is quite possible that the equipment at Scranton, when it was made to conform to Mr. Pomeroy's recommendations, may have needed some adjustment and rearrangement, and yet it is safe to say that it was far more satisfactory than if it had not been based on so careful and pain-staking an analysis. It was possible to get away with rough and ready methods of selection in the past, but the changed conditions will require close and accurate attention to such details in the future.

Weak Spots Automatically Located

Assuming that a railway repair shop plant is already fully equipped and in operation, there is a splendid way in which its weak points in equipment and organization may be automatically located. For many years men of vision in the railroad mechanical department have insisted that shop production could be increased and certain marked economies effected by the inauguration of a shop schedule system which would in effect schedule the exact handling of each individual part in the operations of dismantling, repairing and reassembling the locomotives, so that the progress of the work as a whole would go forward uniformly and rapidly. The locomotive would be kept out of service a minimum time and any tendency to delay in the carrying on and completion of the various operations could be quickly located and remedied. In fact, it makes the shop superintendent or general foreman a real manager of the shop and automatically throws a large part of the routine work on the subordinates. One of its great advantages is that it automatically locates any weak spots in the organization and focuses attention upon them. It can be readily seen how this might result in the development of extremely forceful arguments as to why new and improved machinery is needed to replace the older tools, which, from the standpoint of production, are becoming obsolete.

It is a sad tribute to the lack of vision on the part of shop managements that it has taken so many years to awaken them to the possibilities of the shop scheduling system. Within the past year or two, however, it has been installed in a considerable number of railway shops and it is probably not too much to say that in the very near future it will be used generally in all of the larger shops at least. Such a system, supplemented by a capable machine tool and shop equipment expert, will readily locate those places where the railroads can invest their money to the best possible advantage in building up the weak spots and toning up the effectiveness of the locomotive and car repair facilities.

It is interesting to note that one important railroad system has recently started carefully to analyze the condition of each machine tool in its large shops, including among other things data as to the kind of work for which it is used, the percentage of time the machine is in use, the changes which will be necessary to increase the output 15 or 20 per cent. and recommendations as to whether the machines should be overhauled, improved, scrapped or retired to a smaller and less important shop.

On another road the mechanical department has been very successful in securing appropriations for new machine tools because the shop authorities in asking for new tools must support their requests with an analysis of how the work is being done by the old tools and just how it will be redistributed and what savings will be made when the proposed new tools are installed.

One of the great difficulties in the way of getting approval for the purchase of new tools or equipment is that under any conditions, and particularly under the present financial conditions, the executive officers must have placed before them strong, convincing arguments as to the returns which will be made from the new investment. Only in this way can a wise decision be made as to the order of precedence of the many items which come before them for consideration. The machine tool builder in trying to secure railway business should have a keen appreciation of this fact and should, wherever possible, assist the shop authorities, or those who will decide upon the purchase of the tool, to develop concrete facts as to the savings which will be effected by the installation of the new machine. In the past there has been too much rough estimating or guess work in deciding what new equipment was needed, and the average mechanical department officer has not realized the importance of backing up his requests with a clear and forceful analysis of the savings which would be effected by the purchase of the new tools and equipment.

Where New Machine Tools Are Needed

In general, what are the weak spots in railway machine tool equipment today and where is the greatest need for new tools?

With the high wages, scarcity of labor, great increase in the cost of rolling stock, and the extreme difficulty in getting new equipment the idle time of every car and locomotive must be cut to a minimum. The weakest spot in the railway mechanical department is its engine house or engine terminal facilities. Engine houses have been outgrown because of the rapid development in the number, size and capacity of locomotives.

One mechanical department officer has characterized a roundhouse as "a dark hole with a wall around it." Mechanics have had to work under the most discouraging and difficult conditions as to light, heat, ventilation and facilities. Meanwhile, the locomotives have been growing larger and larger, and the size of parts has developed so rapidly that the workmen have found it almost impossible and very expensive to handle them with the limited facilities at their disposal. Then, too, in the interests of greater efficiency and economy on the road, various devices have been added to the locomotives which have complicated the task of caring for them. The federal boiler inspection, which was later extended to cover the entire locomotive, has added greatly to the need for additional locomotive terminal facilities and conveniences. It is quite generally recognized that the effectiveness of the locomotives could be very greatly increased on most of the roads by a thorough overhauling and even rebuilding of most of the locomotive terminals.

Incidentally, very few of the engine houses have had an adequate equipment of machine tools; such tools as they have had in most cases were passed down to them when they were discarded by the repair shops. In many instances these have been absolutely unsatisfactory for the reason that most of the tools which can be used to advantage at an engine house must be simple, rugged and accurate and yet must readily handle a wide range of work. The older, lighter tools with a narrow range of adaptability have in many cases been unsuitable for the engine house. It is a good sound investment, both from the standpoint of performing the work and of getting better service from the locomotives, to have an adequate machine tool equipment at at least the important engine houses, thus relieving the repair shops of the lighter repairs which in most cases interfere greatly with the scheduling of the heavier repair work. It is significant that a large part of the tools now being ordered by the railroads are for use in engine house work.

In looking into the needs of the repair shop proper, we find that it is true that a few of the tools which may be classed as "ancient" were so well built that by an overhauling and the application of an individual motor they may give good service for some classes of work. Here again a careful study is necessary in which proper weight must be given to each of the several factors involved. Obviously, it will be foolish to make any great expenditure on the rebuilding of an old tool if when the work is all done the machine lacks important features of modern tools in the way of strength and convenience of operation. While it would be unfair to say that the older tools as a class should be entirely discarded, it is true that there are today many tools in railroad shops throughout this country which, in the interests of production and efficiency, should be discarded and sold for junk; it is not even advisable in many cases to think of trying to use them in less important shops or in engine houses.

In one large shop which is fairly well equipped with modern tools it was recently estimated on the basis of a detailed

study that about 5 per cent of the tools were obsolete. This shop, however, represents very much better than average conditions.

It may be argued that the roads cannot afford to buy new tools to replace the older ones. This is not true in many cases, for the roads are wasting more money by keeping the old tools in service than if they were to "take the bull by the horns" and get rid of them. There are any number of tools in the railroad shops of this country that are more than fifty years old, and many that were installed in the "sixties." How any mechanical department can justify the continued use of these tools is a question which it is difficult to answer.

It is important when a road is contemplating the purchase of locomotives that it consider at the same time the additional facilities which will be required to care for the new power. The shortsightedness of overlookng this was clearly shown three years ago when the roads under great stress awakened suddenly to the fact they had steadily been adding to the number and size of their locomotives for years without making a corresponding increase in the facilities for taking care of them. Not a few roads are today years behind in their machine tool and shop equipment. This must be made up.

Many special tools are needed in the shop today to provide for the larger car and locomotive parts which have been introduced in recent years. In discussing some of these special tools a mechanical department superintendent is responsible for the statement that: "We are performing many operations on old tools which should be done on modern tools at a saving in time amounting to 75 per cent at least."

A number of roads have found it profitable to establish central manufacturing plants to produce certain parts, wholly or partially finished, which could be shipped to the repair shops and engine houses. The possibility of savings are great. Not only is the manufacturing cost very considerably reduced because of the use of special machinery and quantity production, but the operations of the repair shop and engine house are not hampered by needless work. This development has created a demand for certain automatic, semi-automatic and production tools, and the indications are that the practice will be very considerably extended.

In looking over the special departments, a great need will be found in many boiler shops for adequate punching and shearing machines and bending rolls and flanging machines sufficiently powerful to handle quickly the heavy sheets which are used in modern locomotive boilers. The need of more powerful drill presses for some classes of boiler shop work is also apparent.

Many blacksmith shops are hampered by the lack of sufficient power-driven hammers as well as suitable presses for making steel car repairs, and forging machines of sufficient capacity to make parts which are now being formed on the anvil.

How Manufacturers Can Help

Machine tool builders, particularly those making types of tools specially adapted to railroad use, have given remarkable cooperation to railroad shop managements, not only in developing the special tools but in demonstrating them and in helping in many cases to plan for the arrangement of the necessary accessories in order to get the best use out of the tools. This has been appreciated.

Railroad officers have also been keenly appreciative of the concrete data which the machine tool builders have put forth in their publicity campaigns, showing exactly how different classes of work are done on their machines and accompanied, where possible, by time studies. This has helped the railroad men to bring the advantages of the machine tools in question before their managements in such a way as to have their requisitions approved.

There have been some criticisms of railroad shops because of their not having ordered more of the very high capacity machine tools. As one mechanical superintendent put it in discussing the problem: "The entire question of production is fully as much a question of shop management and mechanical engineering as it is of shop tools." Some mechanical department officers, for instance, have decided that it is better to smooth forge a side rod and machine only the ends than to provide a high powered machine to finish the entire rod. The machine tool builders can be helpful in assisting to work out problems of this sort.

There is another way in which the machine tool builders can co-operate with the railways. Director General of Railroads Hines, just before he retired from that position, made this statement before the National Press Club at Washington, D. C.:

"I regard the next two years as a peculiarly critical period. The opportunities for the development of discontent are very great. The increases in rates cannot inspire enthusiasm, and service is bound to be unsatisfactory, especially until a large amount of equipment can be constructed. Yet both these factors ought to be regarded as necessary incidents of the times in which we live." And again, "The prospects of success will be promising if there can be an attitude of patient support on the part of the public and a proper disposition on the part of the corporate agencies and labor agencies to cooperate with each other and with the commission."

The prosperity of the country and of your business depends on the success of the transportation machine. Will you do your part by cooperation, influence and patience to help put it on its feet?

LUBRICATION OF SOFT METAL BEARINGS*

BY W. K. FRANK

Friction is the name given to the force which opposes motion and is, therefore, ever present between the journal and the bearing. It is found in all manner of mechanical devices and, strangely enough, is one of our most valuable and at the same time most destructive forces. Without friction, brakes would lose their value and nuts would never be used on bolts. Trains would of necessity run on tracks provided with gear teeth, and we could not walk as we do now but would be compelled to find other means of locomotion. Friction, however, is not desirable in bearings. Although much experimental work has been done on this subject, the laws of friction are as yet but little understood.

The surfaces of all materials which appear smooth are in fact made up of microscopic hills and valleys. When two surfaces in contact are moved relatively to each other, the clashing of the points creats a force which opposes motion. Wear results from this action and the energy expended is converted into heat.

Fluids, as well as solids, show friction, and this has been described as the force encountered in rolling the particles of the fluid against one another. The laws of friction in fluids and solids are quite different, and these have been summarized as follows: For solids, dry or slightly lubricated, frictional resistance is proportional to the load; it is independent of the extent of the rubbing surfaces; except at very low speeds it decreases as the velocity increases.

In liquids the frictional resistance is independent of the load; is directly dependent on the extent of the rubbing surfaces; and increases as the velocity increases.

The function of the lubricant in bearings is to separate the surfaces by a film so that metallic contact does not occur. If such a separation does take place the friction resulting will

*Second article abstracted from a paper presented before the Engineers Society of Western Pennsylvania.

follow the laws for fluids. It has been well established by Tower that under conditions of perfect lubrication the journal is actually fluid borne, and in this case the laws of fluid friction may be applied. He showed that when a bearing is plentifully supplied with lubricant the friction depends very little on the load or the character of the surfaces, but is dependent on the extent of the surfaces, the velocity and the character of the lubricant.

Tower's experiments were made with the load and bearing above a journal, the lower part of which was immersed in a bath of oil. He found that the journal carried the oil between the surfaces and formed a film between them. One of the most interesting points of his experiments was noted quite accidentally. In the course of his work he had occasion to drill an oil hole at the top of the bearing and found that the oil flowed freely from it. He attached a pressure-gage at this point and determined that a pressure of over 200 lb. per square inch was developed, although his load was only 100 lb. per square inch of projected area. Later experiments showed that the pressure of the film at the top was greatly in excess of that at the sides and that it was greater on the discharge side than on the entering side. The thickness of the film has been determined as between 0.0013 and 0.0029 in.

However, in most applications such ideal conditions are not reached, and usually on starting the surfaces are in contact and subject to the laws of friction for solids. Lubrication is often interrupted or imperfect, by reason of improper distribution, and friction does not follow exactly the laws either of solids or of liquids, but is intermediate between them. This is the type of intermediate friction encountered in bearings with which the present paper deals, and it is necessarily an indefinite quantity depending on all of the named variables. It will be seen that the matter of the character and supply of lubricant, as well as the nature of the surfaces, will be important factors in determining the friction and wear of the surfaces.

Since lubrication is so vital in the matter of friction and wear, prime consideration should be given to it in bearing design. Every effort should be made to create a film, although it is not always practicable nor desirable to provide bath, flood or forced lubrication. Various methods for supplying the lubricant are in use. Drop feed lubrication, which is the simplest form, requires only a hole in the bearing through which the oil is introduced. Unfortunately, this hole is often placed at the point of greatest pressure, so that no opportunity is allowed for the establishment of a film. Introduction at the point of minimum pressure would probably reduce both wear and friction.

Saturated pad lubrication is employed in some cases, the most common example of which is the railroad car bearing. The bearing covers only the upper third of the journal and waste, saturated with oil, is pressed against it from below.

Ring or chain lubrication is used on many line-shaft bearings and on the bearings of electrical equipment. Chains or rings are provided of a diameter considerably larger than the journal and resting on it, and these run in grooves in the bearing and through a reservoir of oil. Good results have been obtained by this method, and it is claimed by some authorities that conditions closely approaching perfect lubrication are reached.

Flooded lubrication consists of pumping the oil or carrying it by gravity in large volume to the bearing and delivering it at practically no pressure. Perfect films are often obtained, and the added advantage of dissipating the heat of friction brings it into use with large high-duty bearings. Forced lubrication is used in a limited number of cases. Oil is pumped to the points of maximum pressure and a perfect film is maintained. The pressure of delivery at the bearing must, therefore, be above the pressure of the film, and ranges from 15 lb. per sq. in. to 600 lb. per sq. in.

Grease lubrication is applied principally to heavy, slow-moving machinery. Considerable friction is encountered from the lubricant itself, but under heavy pressures the "body" of the grease prevents abrasion by the tenacity with which it clings to the respective surfaces and separates them.

Oil grooves are resorted to in many bearings in an endeavor to secure a film. However, when the film is once formed the grooves are a distinct hindrance to its maintenance. Grooves should, in general, not lead into the region of maximum pressures, as in this case they may actually lead the oil away from instead of towards the place where it is most needed. Grooves should preferably be placed in the region of minimum pressures and should run parallel to the axis of the shaft. Care should be taken to round the edges of the grooves to minimize the danger of injuring the film.

In bearings subjected to heavy loads the oil or grease may be entirely squeezed from between the surfaces when motion ceases. Grooves to the pressure points will provide convenient reservoirs of grease for starting and thus prevent abrasion, and this is the only case where such grooves should be countenanced. Errors in locating grooves may be avoided, to a great extent, by keeping in mind the desirability of securing films.

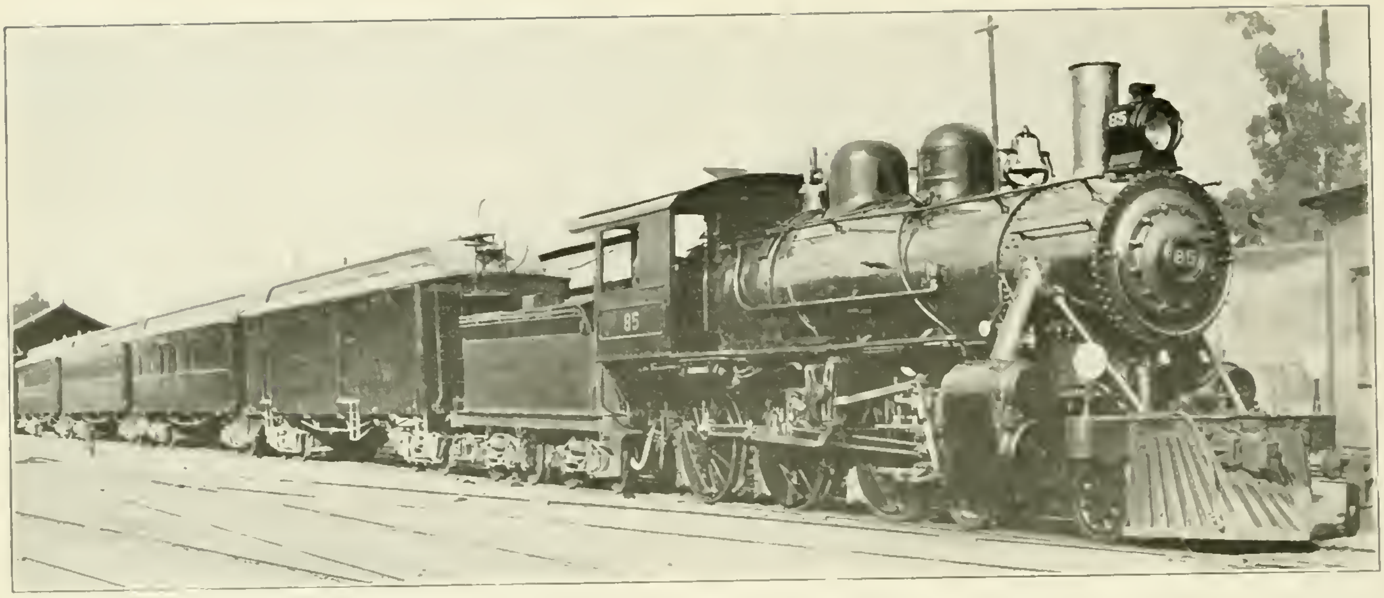
Another factor in securing proper lubrication is clearance between the bearing and the journal. Where the bearing covers only a portion of the journal, the latter can be made smaller in diameter, thus providing clearance at the minimum pressure sides. This is often further increased by planing away additional metal from these sides. The amount of clearance desirable will vary with the velocity of the journal and the nature of the lubricant, but in general it can be said that too much clearance will decrease the opportunity for the formation of a film. The error, however, is often made on the other side—that is, too little clearance is provided. It should be remembered that the bearing is often rigidly held, so that with a temperature rise expansion of both bearing and journal tend to decrease the space between them.

Clearance should be provided between bearing and container, whenever possible, to allow free expansion. Without this, expansion of the back of the bearing may cause pinching off of the lubricant at the sides and what are apparently perfectly fitted bearings, when cool, may be in fact very badly fitted when they become warm.

Dissipation of heat from the bearing is a matter which is often overlooked. The heat of friction is usually carried away by radiation, but in some cases cooling is accomplished by currents of air, oil or water. Water cooling is often employed, but in some cases this is not practicable and the bearing is called upon to run at high temperatures.

Bearing design is sometimes checked up by the product of pressure, in pounds per square inch of projected area and velocity in feet per minute. Various values have been assigned, ranging from 24,000 to 1,720,000. One manufacturer of heavy machinery limits this value to 60,000 for ordinary lubrication, while 1,100,000 seems to be good practice for locomotive main crank pins.

As will be seen from some of the precautions in design, the bearing that has the best lubrication will last longest, other things being equal. Grit and dirt will often start scoring, and it may be of interest, in passing, to note that this remedy is sometimes used in curing hot boxes. Bearings are occasionally so tightly fitted that little lubricant can enter between the surfaces. Minute oil grooves may then be secured by introducing a small quantity of powdered emery, which makes circumferential scratches on both the journal and bearing surface. Care should then be used in clearing the emery from the lubricant, as abrasion to a serious extent may be caused. Clean bearings, well lubricated and kept in alinement, should give little trouble when properly designed.



Standard Passenger Train on the Southern of Peru

RAILWAY EQUIPMENT IN SOUTH AMERICA*

Difficult Operating Conditions in Peru Have Led to the Development of Unusual Features

BY J. P. RISQUE

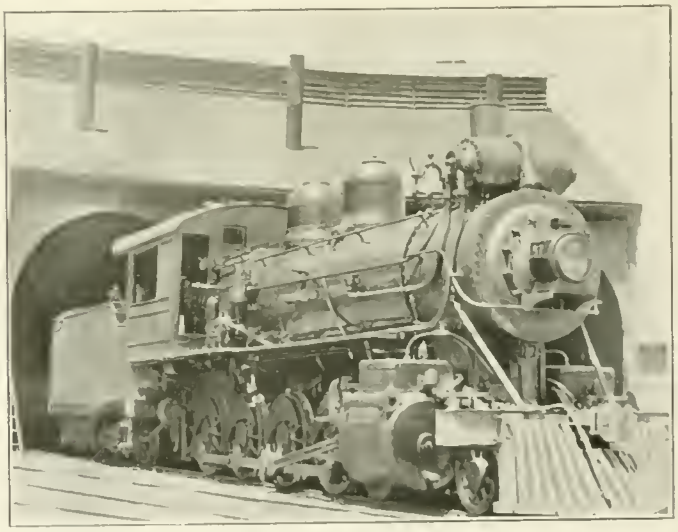
LIKE the old mariner who is said to have been able to detect the class and relative importance of a distant schooner by "the cut of her jib," a practical locomotive man inclines his opinion of a road in the direction of his impressions of its rolling stock. The track may be exceptional, the terminal facilities elaborate, but, as a staunch maintainer of his department's claim that "locomotives are the only things that really earn any money on a railroad" he will reduce his impressions to terms that are expressed in figures that relate to the prime mover. Naturally, those impressions will be tempered somewhat by the showing that is made in the road's car department—otherwise the alleged truth of his slogan could not even have the importance that the other departments grudgingly allow it.

To this individual the size, type and class of power on a line, as well as the cars, their upkeep and apparent condition is the outward sign of the spirit of progress or its absence. He will just as naturally look for superheaters, feedwater heaters and other modern improvements that create economy and shorten time that doesn't produce, as he looks for sugar in his coffee. Their general omission is to him an index of the management's mental process toward the cost of the haul.

As the average American railroader's knowledge of the lines outside of his own country, and particularly of those in South America, is meagre, the reports that reach him from time to time from tired travelers in those parts to the effect that "the cinders from a wheezy old wood burner at the head end of the train, set fire to the clothes of the passengers in the coaches behind," have not perceptibly increased his interest in either the railroader or his equipment in those lands. This scant understanding of the extent and importance of some of the real transportation achievements on the continent to the south of us has, in a measure, deprived him of the benefits of some of the lessons they hold, chief among which is the lesson of thoroughness in every thing that is done.

British Equipment Predominates

A student of locomotive design who is more or less familiar with the principal characteristics of British practice would become impressed with the dominance of the latter



Cross-Compound Consolidation on the Southern of Peru Equipped With Dalzell Feedwater Heater

types, particularly in certain sections. That this condition is logical is attested by the fact that about 65 per cent of the roads are owned and controlled by British capital and operated by British nationals. And on other roads, operated by the governments of the respective countries or by other non-British owners, the type referred to is largely represented, due partly to the influence exerted by the performance

*This is the first of a series of articles by Mr. Risque, who has recently returned from a trip through South America as an editorial representative of the *Railway Mechanical Engineer.*

of those types and partly to the American builders' ancient indifference to the unexpected possibilities. Thus, in a trip of inspection over some of South America's principal lines, an observer would come to look upon the appearance of any great number of American built locomotives—and particularly of American design as an exception, not a rule.

Descending the West coast the first important railways encountered are the various government owned short lines of Colombia, the nucleus of what will probably be, someday, a unified system. Further south is the narrow gage Guayaquil & Quito line operated by an American company between the two points named, in Ecuador. As neither of the aforementioned roads present significant differences in equipment or manner of operation, at least on a scale comparable with that which follows, a description of them is omitted.

The Railways of Peru

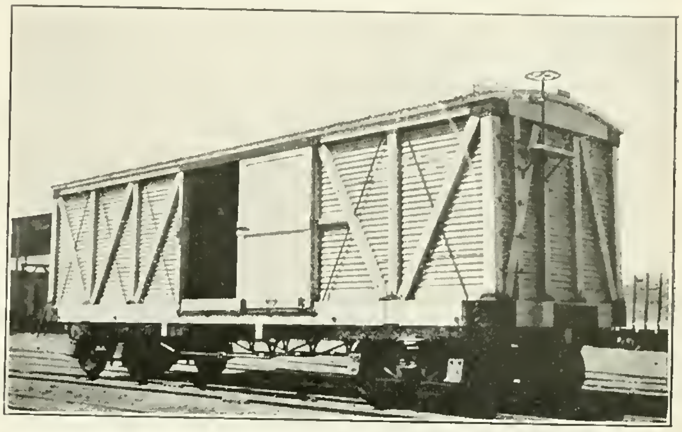
Among the very interesting contributions to the exception previously mentioned, is the equipment on the lines in Peru, controlled by the Peruvian Corporation, a British institution throughout, whose directorate resides in London. An American railroader would feel perfectly at home here, for

The General Manager's Private Car, Built Complete at the Arequipa Shops

with the exception of a few light side tank suburban locomotives of British design, the entire equipment is of American manufacture and style. For convenience in this description the corporation's holdings can be said to be located in three districts. The first comprises some lines operated north of Callao—unrelated short feeders from mines or sugar plantations, to the coast. The central of Peru, running northwest from Callao to a point on the roof of the world, called Oroyo, thence southwest a short distance to Huancayo, makes up the second section; and the Southern of Peru from Mollendo, inward to Lake Titicaca to Cuzco in one direction and La Paz in another, carrying its freight and passengers across the lake in its own steamers, composes the third section.

Aside from the shortness of the trains which are limited to four cars by the average lengths of 21 switch backs traversed in the run of 247 miles from sea level to an altitude of 15,665 ft.—all in seven hours—there is little to be mentioned as the equipment is American throughout. As words are inadequate to describe the scenery on this ride it will suffice to say that if this asset could be capitalized this road would emerge from the position of an obscure carrier of supplies from the Port of Callao to Lima and the mining camps in the skies above it, to the richest passenger carrier in the world, compared with which the present receipts from copper carried down the hill would be insignificant. This section is more a study for the locating engineer than a student of operation, many of the former of whom it is said can with difficulty conceive of the brain that planned it, much less comprehend the determination of the celebrated engineer who put it through. It is the engineering wonder of South America.

The third section referred to—the lines known as the Southern Railways of Peru—while somewhat less picturesque, offer many items of interest to a practical railroader. Here, too, will be found locomotives and cars and other interesting devices of American types and manufacture in the motive power department, where, during the war the chief mechanical engineer of the system, H. E. Dalzell,

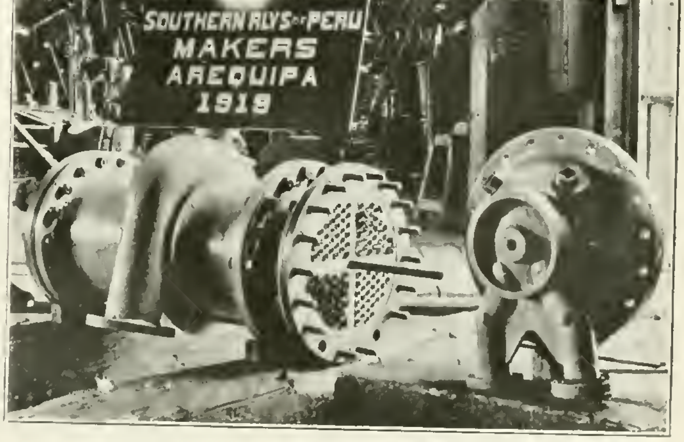


Standard 30-ton Box Car Built at Arequipa Shops

adequately proved the truth of the old assertion that "necessity is the mother of invention." For materials were scarce and some indispensables were unobtainable at any price. And as this period of distress seems to have so efficiently "put them on their own," they have been at it ever since. As a consequence much of the previous dependence on outside manufacturers has given place to home-made equipment, of which there is a variety.

Modern Equipment on the Southern of Peru

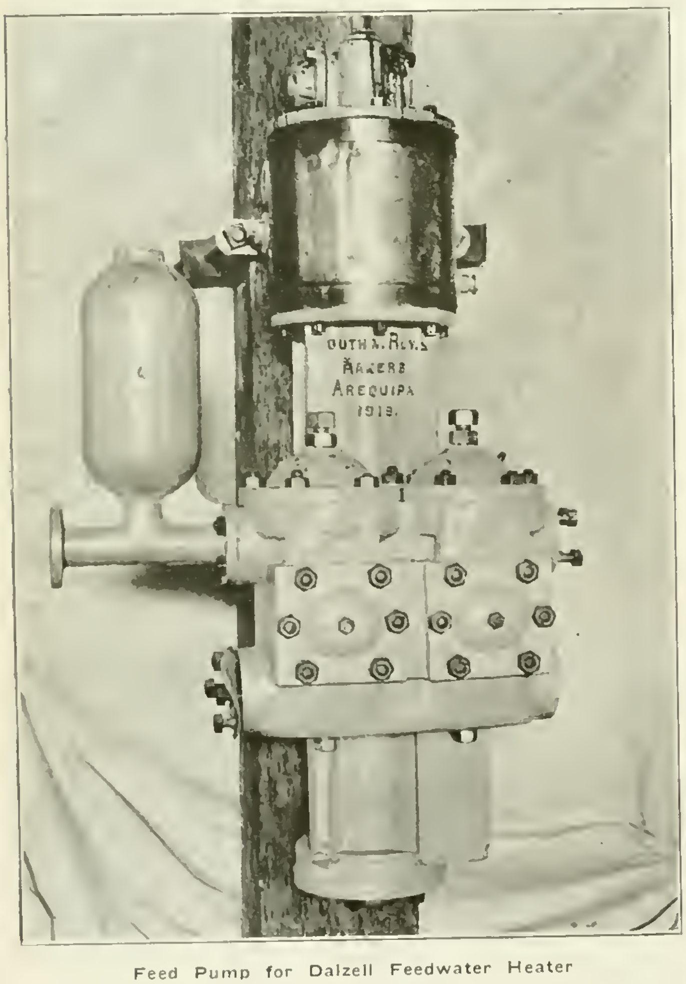
At the Arequipa shops, the principal repair headquarters for the line, the road turns out castings up to five tons, casts, assembles and applies complete superheater units among which are sets running successfully with the original slide valves aided by a special lubricating system. There has



Feedwater Heater Designed and Built by Motive Power Department at Arequipa Shops

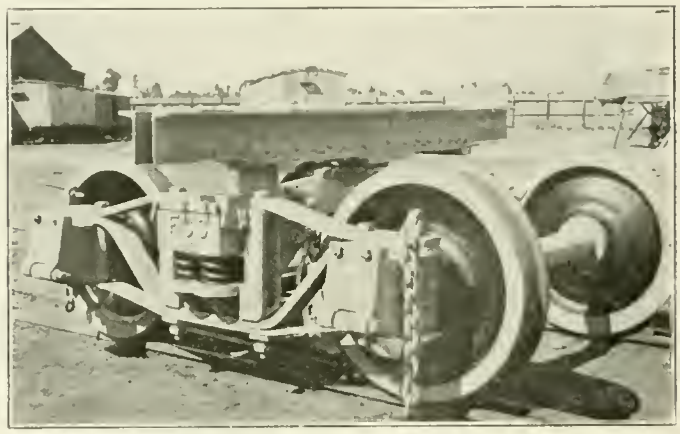
been designed and manufactured complete by the chief mechanical engineer at this point a feedwater heater which has been applied to a 4-8-0 two-cylinder compound freight engine whose operating records showed an economy of seven per cent before the installation. The engineer on this particular locomotive in his competition for the monthly "fuel economy prize" has been handicapped 10 per cent over

his fellows—but he always gets away with the money! As a consequence, the chief mechanical engineer is busy with materials for equipment of the remaining engines. The heater is mounted in front of the stack; the feed pump, the steam end of which is an old Westinghouse 9-in. cylinder, is mounted upon the right hand running board. The exhaust nozzle was reduced seven per cent for the purpose and a branch pipe carries a portion of the exhaust through a pipe in the top of the smoke box, over into the top of the drum of the heater. With water in the tender at 63 deg. F. and the pump running at 15 strokes per minute, the feedwater temperature is raised 140 deg. and passes under the check valve into the boiler at 203 deg. Results from the operation of this engine, No. 57, show that during five months' running repairs to the heater cost $5.10, while the engine hauled 178-ton trains up-grade against 160 tons hauled by those of the same type and size not so equipped. The kilos of coal per kilometer show 9.2 per cent economy in favor of the heater; kilos of coal per ton-kilometer reveal an economy of 18.2 per cent. The actual saving in coal is 2.09 kilos per kilometer. As these engines are making 30,000 kilometers a years the total saving is about 62 tons a year, which at the prices paid for coal in these parts (56.77 soles per ton) is equivalent to approximately $1,775.



Feed Pump for Dalzell Feedwater Heater

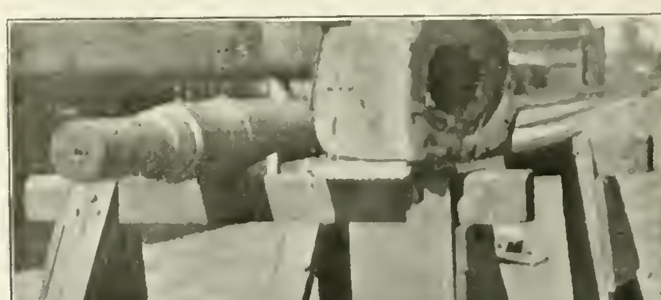
All front ends have been standardized, electric headlights are used on most of the passenger engines and orders for additional sets are being put through from time to time. All the corporation's cars are manufactured complete at the Arequipa shops and the only parts imported for the trucks are rolled steel wheels, chilled cast iron having been found impracticable owing to brake shoe friction and consequent excessive heat which cracked them. Seventy-one 30-ton box cars have been turned out at the Arequipa shops as well as twenty-three 50-ft. first-class passenger coaches, the latter electrically lighted from locomotive headlight dynamos. The plant is now preparing for the construction of two 60-ft., six-compartment sleeping cars and a 60-ft. diner, and a possible purchase of four locomotives was said to be under consideration. In and around the roundhouse and repair shops as well as coach building shops at Arequipa there is an air of effectiveness that is produced with an outlay that is meagre. The observer with his eye peeled for the reasons will find that in the absence of steam for the blacksmith shop hammers (the works are run by electricity purchased from the local city power plant) compressed air from a motor-driven compressor is used. This air, piped around the place keeps the drop yard's 10-ton locomotive crane, as well as the air tools busy—of which there appear a variety. Three sets of Lincoln arc welders and an oxy-acetylene outfit are in use and there was in process of assembling, for use at outside points, a portable outfit comprised of a four-cylinder gasoline motor truck engine, belted to a dynamo and arc welding set.



Truck Made Complete at Arequipa, Except Schoen Steel Wheels

Difficult Operating Conditions in the Andes

Grades and curves are the principal handicaps to the hauling problems on this mountain road. The coal consumption on the grade has been reduced by the use of superheaters, some of which are in use and others being put en as fast as engines are shopped, as well as by the use of the feedwater heaters described. Ten tons less dead weight in tenders is effected by cutting down the tender water space. Ninety-meter radius curves, with which the line is plentifully supplied, have played havoc with axles, cutting off the collars at the ends, making short work of brasses and boring out the inside faces of journal boxes where the hub of the wheel exerts its force in the end thrust.

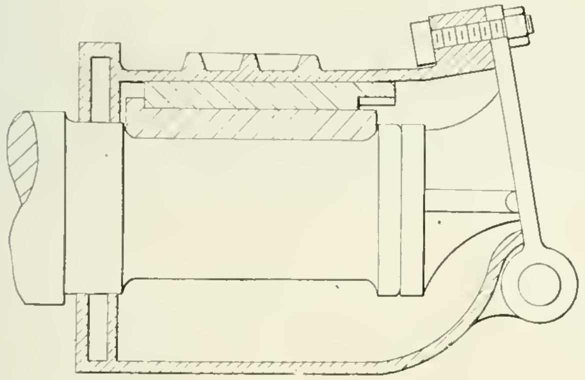


Wear on Axle End and Journal Box Caused by 90-Meter Curves

A cure for this difficulty was found in the chief mechan-

ical engineer's design of a special journal box lid which has a lug cast on its inside face, on the surface of which is cast a bed of anti-friction metal about ¾ in. thick. The lid is held down on the box by two ⅞-in. bolts and raised letters on the lid admonish all concerned to "always keep the nuts screwed down." This device is being applied to all rolling stock gradually and is automatically prolonging the life of journals, boxes and brasses.

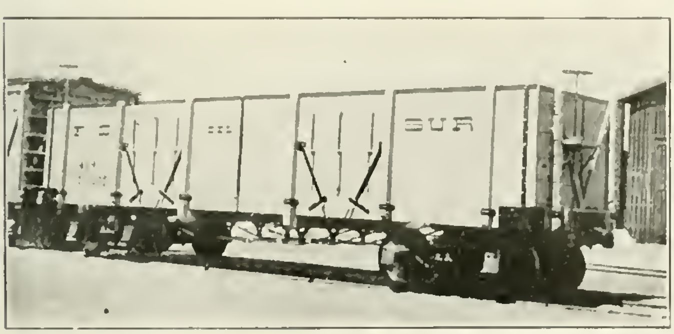
Old axles are reclaimed in the blacksmith shop by heating the ends, upsetting them and welding on a lug. A horizontal ram hung from the steel girders of the shop roof is operated by a cable attached to a clutch; the shifting of a lever swings the ram and the reinforced axle is then turned down in a lathe. One man and two helpers turn out reclaimed axles at the rate of five in seven hours.



Section of Dalzell Journal Box

Contrary to the general impression, the Southern, like most all of the South American lines, has had its struggles with the fuel problem. Coal has been costly and difficult to obtain. Previous to the outbreak of the war briquettes from Wales formed about 57 per cent of the supply at a cost of about $30 a ton at Mollendo. Since the war Fairmont, Pocahontas and Vancouver coal has been used. The mechanical department is now preparing to convert all power to oil and it is expected that by the end of 1920 Peruvian oil will be used universally on the system.

Water conditions are said to be fair all along the line with the exception of bad conditions on the Mollendo-Arequipa divisions, which are supplied by a pipe line from Arequipa all the way. Plans are under consideration by



Coal Car Built at Arequipa Shops. Note the Door Fasteners

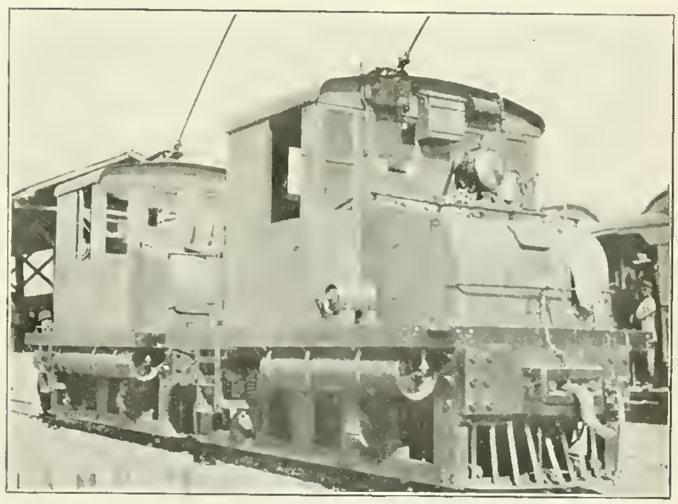
the management for improving this condition in some manner, either by the installation of individual water softening plants or a single unit at Arequipa.

All passenger trains are equipped with Westinghouse air brakes which combine straight air and automatic features. Freight trains are hand braked exclusively owing to the existence of a large number of old cars to which it has been deemed impractical to apply air brakes. For the same reason, link and pin couplers are found, old bodies being of insufficient strength to support the draft gears. As new equipment is built it is expected that the line will gradually outgrow the present forced limitations and will become standardized throughout.

Included in the interesting variety of equipment found on this railway are two Hudson supersix motor cars, equipped with flanged steel wheels with brakes on all wheels for the entertainment of tourists who are willing to pay the price for the novelty of a fast ride over the Andes. A testimonial of their worth and continued patronage is evidenced by the care with which they are maintained and their availability at a moment's notice. The operating results for these two cars show that they make 31 kilometers to a gallon of gasoline.

The Electrified Division

The electric division, running from a point called Alto, within nine kilometers of the terminal in La Paz, is constructed along a sheer cliff and the descent is 1,500 ft. with 6¼ per cent grade. Its operation required a choice between Shay type locomotives and electricity and the latter was chosen as the most acceptable solution of the problem. The power house is located slightly above the city of La Paz



Two 2-Ton Electric Locomotives on the La Paz-Alto Section

at an elevation of 13,000 feet and contains two Boleneder type Deisel engines which are capable of the development or 400 b.hp. at sea level. These engines are direct coupled to two 180 kilowatt, 550 volt General Electric generators running at 165 r.p.m. There are also two 400 hp. producer gas engines belted to two 150 kw. generators for emergency use. A 1,160 ampere hour capacity Tudor battery is run in parallel with the above plant and is charged and discharged through an automatic reversible booster. The line is of ordinary .0000 grooved copper wire, supplemented by ample feeders tapped into the trolley wire at intervals of every half kilometer. The motive power on this division includes two 20-ton, 550 volt D.C. electric locomotives of the type illustrated, four 4-wheel trolleys and four 4-motor combination baggage and express cars.

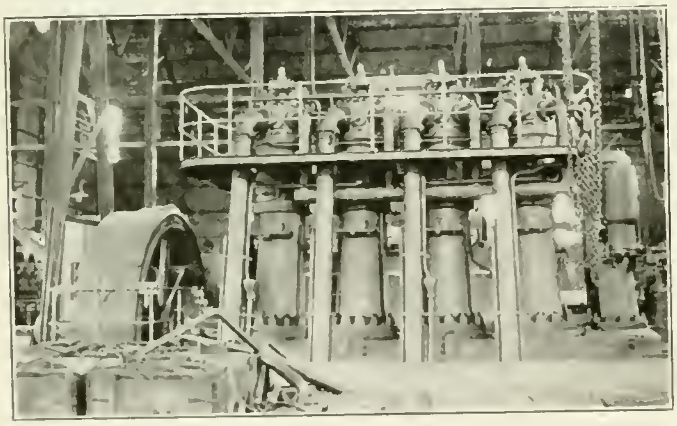
Equipment on the Lake Division

Puno on the west and Guaqui at the east end of Lake Titicaca, both being terminals on the division from Juliaca to La Paz, are adequately equipped for quick transfer of freight from cars to ships and vice-versa by means of batteries of four 5-ton steam cranes on runways. The loading record at Puno is 750 tons per vessel, in one day. Passengers descending the west coast, en route to La Paz, generally

arrive at the lake in the evening, and cross the lake during the night, but the picturesqueness of the scene is available to early risers the next morning.

The corporation operates four steel steamers on the lake. The largest ship in the fleet is the Inca, a 750-ton capacity cargo boat, built to British Admiralty specifications with twin screws, forced draught and superheater equipment and having accommodations for 70 first class passengers. This boat is generally used in the service between Puno and Guaqui, direct. The Coya is a 450-ton capacity boat, also with twin screws and a first class passenger accommodation of 74 and likewise makes direct runs. The Yavari, a 165-ton capacity ship is used as a coasting vessel, making about twelve local calls around the lake, discharging imported supplies from Mollendo and picking up wool, potatoes and other native products. Under the direction of the chief mechanical engineer of the line, this ship was recently entirely reconstructed and lengthened and the original steam engines were replaced by a 320 hp. Boleneder internal combustion engine for burning Peruvian oil. The fourth boat is the tug Yapura which carries 100 tons of cargo with two steel lighters of 120 and 200 tons capacity, respectively, which latter were built complete at the Arequipa plant.

Coaling Steamer Inca at the Puno Wharf



One of the 400 b. hp. Diesel Engines Working at 13,000 ft. Above Sea Level, Supplying Power to the 10 km. Electric Division

Practically all of the line's freight has its origin at the Pacific port of Mollendo, thus resolving the road's hauling problem into one of an up-hill struggle from sea level to an elevation of 14,000 feet, varied only occasionally by stretches of level pampa. Five and six car passenger trains are operated daily between Mollendo and Arequipa as well as a minimum freight service of two daily trains of 175 tons maximum up-grade, each way. Three passenger trains a week of six cars each and chair cars twice a week make the run from Arequipa to Puno. Four or five sections of freights of 175 tons each are sent up to the highest point called Pellones, beyond Arequipa, where the accumulated loads are hauled by one locomotive to Juliaca whence the loads are distributed for Puno and Cuzco.

BOILER CORROSION

In a paper on the Protection of Boilers from Corrosion, abstracted in The Engineer, E. Hoehn, engineer-in-chief to the Swiss Association of Steam Boiler Owners, of Zurich, describes experiments made by the association during the years 1915 to 1917 with a view to finding out the best means of preventing internal and external rusting. After dealing with relatively expensive methods, it passes on to the consideration of the use of protective coatings of various kinds. Some are proprietary compounds and some are not, but the two which appear to give the best results are cement and a mixture of 75 parts by weight of distilled gas tar and graphite. The cement has the advantage that it can be applied without any special precaution, while cases have occurred of men being overcome by the fumes of tar when treating the inside of boilers.

The discussion on the employment of cement is exceptionally interesting and is supported by a number of experiments made for the association both in a laboratory and in boilers in actual use. It appears that a thickness of about 0.02 in. is sufficient, and that if the wash is brushed on to a cold boiler and given 24 hours at least to set, it will adhere very strongly to the surface—even if it be slightly rusted to begin with—and that the higher the boiler temperature the harder the coating will become.

Of the mixture of tar and graphite Mr. Hoehn says that it is of the highest importance that only distilled tar should be used, as crude tar contains destructive acids. A wash of cement on the colder parts of boilers at least is no new thing, but it is doubtful whether it will stand the frequent changes of temperature and pressure and the consequent movements of the plates. The tar-graphite mixture is no doubt flexible and might not fail in the same way, but would it endure on the hotter surfaces? Such questions as these can only be adequately answered by prolonged tests under working conditions.

The Inspection of Freight Equipment*

Maintenance of Trucks, Lubrication and Packing of Journal Boxes, Defects of Wheels and Axles

BY L. K. SILLCOX
Master Car Builder, Chicago, Milwaukee & St. Paul

ONE of the most important items to be considered to insure the cool running of journals is intelligent, systematic and periodical attention to the packing in boxes on equipment in service. Briefly, this should consist in lightly loosening up the packing with the packing iron to avoid the hardened and glazed condition which results when packing has remained too long in direct contact with the journal. This is not to be interpreted to mean that trains in service are to have the packing poked up more often than once in every five hundred to one thousand miles run, as otherwise it will result in it becoming all cut to pieces through continual jabbing and mechanical wear and tear. In explanation, trains on coast line runs may have the packing loosened up so as to come in contact with the journal or turned over with the standard packing iron at Aberdeen and Deer Lodge, as well as at originating terminals. It is the intention to change the packing in journal boxes under cars once a year, and as the date is clearly stenciled on the sides of the car showing when removal was last made, it will be necessary for car inspectors to follow this closely, and in case this is not being given the attention required they are to notify their immediate superior of the fact. Car inspectors and others are cautioned to examine the end of the journals at the centering hole to see whether they present a dry condition; if so, it is almost a certain indication that something is wrong and the brass should be removed and examined.

Wheels should be inspected to discover those having cracks, seams, flat spots, loose on axles, broken flange, chipped flange, worn flange, shelled out, tread worn, chill worn or worn beyond the condemning limit.

Lids on journal boxes should be lifted to make inspection of sponging, journal bearings and journal bearing wedges to see that they are in proper condition and journals not cut. Journal bearings and wedges should be in proper position in the box and the sponging in place well to the back of the box and up under the journal. Box lids should fit well in place and be properly secured to exclude dirt and dust. Under no circumstances are journal box lids to be left open for any considerable time or when trains pull out for the run. A supply of the various kinds of oil box covers must always be kept at hand and inspection stations must be fully equipped with some kind of cover or lid, at least, so that each box before it leaves for movement on the line will be supplied. In case of foreign cars, where no possible pattern, either wood or metal, is obtainable, a piece of wood or old galvanized roofing should be employed.

No part of the body or truck frame or attachments shall be less than 2½ in. above the top of the rail.

Preparation of Journal Box Packing

The standard instructions covering the preparation of journal box packing provide that the waste be carefully pulled apart and a known weight placed in the preparation vats, adding sufficient oil to completely submerge the waste (for 50 lb. of waste this will be 60 gal. of oil). The waste and oil should be allowed to stand for 48 hours; drawing off the excess oil (in above case this would be 55 gal.), leaving just a sufficient quantity to maintain the ratio of four pints of oil to each pound of dry waste. The work should be performed in a room at a temperature of about 70 deg. As the oil continues to drain, it should be drawn off from the bottom of the vat and poured back over the top of the waste, thus maintaining the proportion of four to one until all packing is used, and having the packing always ready for service. In tanks of two or more compartments, one can be used as storage for prepared packing, while the other is being used for the saturation of fresh packing.

The man in charge of the oil room should be thoroughly instructed to drain off the oil that settles in the bottom of storage tanks and to pour it back over the packing several times daily. By these instructions, it should be understood that when the oil is poured over the packing it must be equally distributed to cover the entire surface of the packing contained in the storage tank. The oil rooms should be kept

*Sixth of a series of articles on this subject by Mr. Sillcox.

clean and free from dust and other foreign matter at all times, and no dry waste or wiping towels allowed to be carelessly thrown in or mixed with the packing.

In addition to these tanks, it is necessary to have a metal container to hold rolls that have been made up of dry waste which have afterwards been submerged in oil. These are rolls to be used without carrying much oil, or in other words, moderately dry, in order to have them ready to apply to boxes at all times. The standard dimensions of these rolls is 2½ in. in diameter and about 11 in. in length. These rolls assist in better excluding the dirt in the back of boxes as well as holding the oil in the box.

A standard dope bucket should be used for handling prepared packing and nothing else. After a train of cars has been gone over by the yard or shop packer, all packing remaining in the bucket should be placed back in the storage tank until it is necessary to go over the next train of cars.

A standard packing iron should be adopted with a sharp end, and the forked end of this packing iron should be maintained in its original condition at all times, as continual use wears down this end. The packing iron should also have a lug about 12 in. from the handhold, which is used to open box lids. A suitable pulling hook is required for each packer on the shop tracks as well as in the train yards. A box packer's outfit should consist of the following standard equipment: Dope bucket, packing iron and pulling hook.

Method of Packing Journal Boxes

The packer should first place the prepared roll in the mouth of the box, using care to center the roll, then with the packing iron it should be shoved back evenly under the journal, so that it is in the proper position when it reaches the extreme back of the box. The packing should be picked up by hand and placed across the entire mouth of the box. This is absolutely necessary in order to keep the packing evenly distributed in the operation of placing it in the box. This method insures an even distribution while being placed in the box, due to feeding the packing in a continuous strand under the journal (not on the sides), until the box is completely packed to the center line of the journal, straight down from the inside face of the collar. Balance of box to be packed loosely with portions of prepared packing and to be separate from that back of the collar of journal. This is to prevent packing under the journal from working forward and away from rear end of box.

When wheels are applied the journals should be thoroughly cleaned, the bearing surface of the brasses coated with oil and a dust guard inserted. No waste, either dry or saturated, should be used in oiling the journal bearing, this to avoid any particle of waste or foreign substance remaining on the journal bearing when it is applied. A film of clean oil should be provided by pouring it from a can. Tight-fitting dust guards should be applied in all cases when wheels or journal boxes are applied. Where new journal boxes or integral truck sides are applied, the interior of the boxes should be free from scale and sand or any other foreign substance.

When the movement of cars is reversed while enroute it is found that the packing works to the rising side of the journal in a great many instances and will remain in that position in the reverse movement if not adjusted, causing journals to heat, as packing in this position will not feed oil to the journal. When box lids are found difficult to open, assistance should be obtained. In no case must a box be jacked up in the yards or shops without first removing all the packing. When a car is found with a hot box or a mark indicating a hot box, a careful inspection must be made to ascertain the cause of heating. If the journal is smooth, apply a new brass and repack with prepared packing. If the journal is rough, a new pair of wheels must be applied. Under no circumstances must a journal which has been heated be reapplied to a car unless it is in a perfectly smooth condition. A journal which has been heated sufficiently to discolor it must never be reapplied unless it is known to be perfectly safe to run.

Journal boxes of freight equipment cars must have the packing removed, the bearing examined and the boxes repacked as the cars receive classified repairs if the stenciling indicates that they have not been repacked within nine months. When newly packed or repacked, they must be stenciled as to the date and place where the work is done.

Care is to be taken to see that all new journal bearing wedges have a crown of almost 1/16 in., and this should be maintained in order to guarantee good results in service. Wedges having the crowned top surface worn flat and smooth for a length from front to back of more than 4 in. should be removed and replaced with new wedges where practicable.

Journal bearings for 5 in. by 9 in. and 5½ in. by 10 in. journals must not be employed in renewals unless at least 1 3/16 in. thick over all at the center. Journals not in service must be coated to prevent rusting. Care must be exercised in loading wheels for shipment and placing on storage tracks to prevent the flanges from coming in contact with the journals.

Truck conditions contribute very materially to the cause of journals heating on freight cars, as for example, the absence of nuts from column bolts and box bolts. Where the nut is missing from the column bolt, invariably the arch bar springs up, throwing the weight on the journal box and putting the box out of line. Where box bolt nuts are missing on trucks passing over low joints and crossovers, it has the tendency to allow the journal bearing to become unseated from the journal and bearing, also causing journal bearings to become broken. Cars with the arch bars worn at the column and box bolt holes, allow the box to cant inward causing the journal bearing to ride partially on the side of the journal. This defect of worn bolt holes is due primarily to nuts missing from bolts or nuts not drawn home, which allows the bolts to keep working upward and downward and also turning when the car is in motion.

Axles

In determining whether axles are worn beyond reasonable or safe limits to continue in service, it is well to bear in mind that the proper maximum limits generally accepted in removing them are (1) if the *fillets* at the back end of journals show less than ⅛ in. radius on axles of 40,000 lb. capacity (3¾ in. by 7 in. journal), less than 5/16 in. radius on axles of 50,000 lb. capacity (4 in. by 7 in. journal) and 60,000 lb. capacity (4¼ in. by 8 in. journal), and less than ⅜ in. radius in axles of greater capacity; (2) if the *journal length* is increased ½ in. over the standard original length when new; (3) if the *collar* is broken off or worn to ¼ in. in thickness or less.

When second-hand axles are applied to cars, the diameter or wheel seats and centers must not be less than the following:

A. R. A. Standard Design.

Nominal Capacity.	Limit Minimum Diameter for Wheel Seat.	Limit Minimum Diameter for Center of Axle.
140,000 lb. (6 in. by 11 in. journal)........	7⅜ in.	6 5/16 in.
100,000 lb. (5½ in. by 10 in. journal)......	6¾ in.	5¾ in.
80,000 lb. (5 in. by 9 in. journal)........	6¼ in.	5¼ in.
60,000 lb. (4¼ in. by 8 in. journal)........	5½ in.	4 11/16 in. ..
40,000 lb. (3¾ in. by 7 in. journal)......	4⅞ in.	4 3/16 in.

Non-A. R. A. Standard Designs.

Nominal Capacity.	Limit Minimum Diameter for Wheel Seat.	Limit Minimum Diameter for Center of Axle.
70,000 lb. (4½ in. by 8 in. journal)......	5⅝ in.	4⅞ in.
60,000 lb. (4¼ in. by 8 in. journal)......	5 in.	4⅜ in.
50,000 lb. (4 in. by 7 in. journal)..........	4¾ in.	4⅛ in.
40,000 lb. (3¾ in. by 7 in. journal)......	4⅝ in.	3⅞ in.

A. R. A. standard axles must be used in replacing A. R. A. axles subject to condemning limits for such axles.

A. R. A. standard axles may be used to replace non-A. R. A. standard axles of like capacity when overall lengths conform to A. R. A. standard lengths, at the expense of the car owner, except that in case of delivering line defects the charge against owner shall be confined to the difference in value between the non-A. R. A. standard axle removed and the A. R. A. standard axle applied. Non-A. R. A. standard axles may be used to replace non-A. R. A. standard axles in kind until October 1, 1920, subject to condemning limits for such axles.

A. R. A. standard 60,000 lb. capacity axles, with wheel seats less than the condemning limit for such axle, but above the condemning limit for non-A. R. A. standard axles, may be replaced in kind, or may be used until October 1, 1920, to replace a non-A. R. A. standard 60,000 lb. capacity axle when the latter is of A. R. A. standard length.

When axles are removed from service on account of wheels having owner's defects, if the diameter of the journal is not at least 1/8 in. greater than the limiting diameter shown, or if the journal is more than 3/8 in. longer than the standard length, or the collar is less than 5/16 in. thick, the axle shall be considered as scrap and so credited.

Rusted journals awaiting application to equipment may be cleaned off with sand paper; a file or emery paper should not be used. Journals should be calipered to see if they are worn hollow or tapered, also, if desired, a steel straight edge may be employed. If the difference between the diameter of the same journal measured at any two points is 1/32 in. or more the journal must be turned.

Axles must be closely inspected for seams, cracks or flaws. Seamy journals may be returned to service if the seams can be removed by turning within the required limits. Cracked or flawed axles should be tested by painting the doubtful parts with white lead paint, and then holding a flatter on the end of the journal and striking it with a sledge; oil working through the paint will indicate flaws. Axles exhibiting cracks or flaws, or showing signs of excessive overheating or below limits in any respect, must be scrapped. Brake rods and brake chains riding on axles must be avoided.

Defects of Wheels

Wheels are not generally safe for movement with the following defects: Slid flat cast iron, cast steel, wrought steel or steel tired wheels, if the flat spots are more than 2½ in. in length, or, if there are two or more adjoining spots each 2 in. or over in length.

Shelled out: wheels with defective treads on account of cracks or shelled-out spots 2½ in. or over, or so numerous as to endanger the safety of the wheel.

Brake burn: wheels having defective treads on account or cracks or shelling out due to heating.

When the worn spot is 2½in. or over in length. Care must be taken to distinguish this defect from flat spots caused by sliding wheels.

Seams—Seams in wheels 1½ in. long or over at a distance of 1½ in. or less from the throat of the flange, or seams three or more inches long, if such seams are within the limits of 3¼ in. from the throat of the flange on the tread of the wheel

Broken or Chipped Rim or Tread—Broken or chipped rim or tread, if the tread measured from the flange at a point 5/8 in. above the rim or tread is less than 3¾ in. in width, or if the bearing face of the tread or rim which may engage the top and exposed face of the rail is more than 3¼ in. wide.

Cracked or Broken Flange or Chipped Flange—Cracked or broken flange, or chipped flange, if it exceeds 1½ in. in length and ½ in. in width.

Wheel Loose or Out of Gage—Wheels are out of gage if less than 5 ft. 4 in. over the outside edges of the rim or 4 ft. 5¼ in. between the inside edges of the rim.

Worn Flanges—Cast iron or cast steel wheels under cars of less than 80,000 lb. capacity, with flanges having flat vertical surfaces extending 1 in. or more from the tread, or flanges 15/16 in. thick or less, gaged at a point 3/8 in. above the tread. Wheels under cars of 80,000 lb. capacity or over, with flanges having flat vertical surfaces extending 7/8 in. or more from the tread, or flanges 1 in. thick or less, gaged at a point 3/8 in. above the tread. In the case of wrought steel or steel tired wheels, flanges having flat vertical surfaces extending 1 in. or more from the tread, or flanges 15/16 in. thick or less.

Bursted Wheels—If the wheel is cracked from the wheel fit, outward by pressure from the axle it should be immediately removed from service.

Type of Wheel to Be Used—Cars intended to be equipped with wrought-steel, cast steel or steel tired wheels, and so stenciled, if found with cast iron wheels, must be changed to the proper standard and at junction points particular care must be used by inspectors on equipment coming from connections and proper record and billing made.

Tread Worn Hollow—Tread worn hollow 3/8 in. or more for a distance of 3 in. is not safe to run and the wheel should be removed from service.

Speaking in a general way regarding the various defects, especially those encountered in connection with cast iron wheels, the following comments are made as information: So far as flat sliding is concerned, the particular point to be noted in cast iron wheels is that the length of the flat spot is generally definite in appearance: the borders of the flat spot are clearly defined and are not pounded out in service, but a characteristic noise is produced which is well recognized and which calls for removal of the wheel under certain conditions. The intensity of the blow on the rail for a flat spot up to 2½ in. long is not very great. The severity of the blow increases as the spot increases, until a maximum is reached at a certain speed, after which a decrease is shown. The critical speed is dependent upon the length of the flat spot. The longer the spot, the higher the speed at which the maximum blow is delivered. Conditions in a steel wheel are somewhat different because of the quality of the material which allows the boundary of the flat spot to be pounded out and lengthened until finally an eccentric wheel is produced instead of the short restricted spot as in the case of the chilled iron wheel. The long rounded spots do not produce a distinctive noise, and, therefore, are not noticed and often wheels remain in service until a very considerable eccentricity is developed, constituting a serious element of danger, especially in cold weather when the track is icebound. The only chance for a chilled iron wheel to develop eccentricity is when worn through the chill. The causes for flat spots in the chilled iron wheel are numerous, and if careful attention is given this matter a very material reduction in their number can be secured. It is generally known that from two to three times as many flat spots develop in the winter months as during the summer months in the colder climates.

The next item of great importance is the subject of broken flanges. The office of the flange is to direct the truck, and, therefore, one flange or the other is in almost constant contact with the rail and subject to rubbing or grinding under considerable pressure. This is especially true when traversing a curve where the flange pressure amounts to 10,000 to 20,000 lb. under ordinary operating conditions and impacts may, of course, momentarily double these amounts. This continuous grinding in the absence of lubrication, results in flange wear.

Seamy wheels, or a seam in the throat, is responsible for a considerable number of broken flanges. There are two classes of seams, one of which develops below the surface of the metal and is known as a blue fracture; the second occurring in wheels of low chill, which is of a progressive

type, starting in small cracks in the throat which eventually unite into a line representing a crack through the chill, which may progress through the grey iron and result in a broken flange. This type of seam can be eliminated by avoiding extremely low chill in the manufacture of wheels. The blue fracture cannot be detected until the surface metal (usually about 1/8 in. thick), is broken through, disclosing the seam below. This type is a foundry defect and can be avoided by pouring iron of the proper temperature in casting the wheel. The cause for these seams, as already stated, is that the iron when poured into the mold first fills the lower part of the hub and then travels through the bottom plate and brackets, filling up the flange. The section of the mold forming the flange is thin and the upper part is formed by the metal chiller. It will be readily seen that the metal in the flange would be cooled somewhat by passing over the cold sand of the mold and coming in contact with the chiller. This metal is also not stirred or mixed by the subsequent metal entering the mold, as it flows on top of that which forms the flange. It is evident that the metal in the flange has already set solid and has started to contract, while the metal above the throat is still in a pasty condition, with the exception of a thin layer of surface metal which was quickly cooled by contact with the chiller. The more rapid cooling and contraction of the metal in the flange, as compared with that of the tread, tends to cause a separation, or seam. This is only true, however, where the iron when poured was not of a sufficiently high temperature to set homogeneously throughout the tread and flange section.

Brake Burning—The question of brake burnt wheels has already been mentioned. In brake burnt wheels, the tread is broken up in fine hair lines running parallel to each other across the tread of the wheel, generally covering a considerable portion of the circumference.

In extreme cases the cracks may open considerably, even though no metal is broken away; this is brought about by the rapid heating and cooling of the tread over the area covered by the brake shoe.

In freight service brake burnt wheels are developed in great numbers in sections of the country where heavy grades are most frequent and where the tonnage per effective brake is greatest. On heavy grades the brakes are applied to control the speed and therefore the action may be prolonged indefinitely. Under such conditions there is very little danger of sliding the wheels, hence the entire circumference becomes intensely heated, and when the heat becomes excessive and is generated in a sufficiently short period of time, it will cause the metal to break up into fine heat cracks, which have already been described.

In most trains there are a number of cars in which the brakes are ineffective or cut-out. The effect of this is to increase the tonnage to be controlled by the remaining cars having effective brakes, and even under these unfavorable conditions there is not much danger of burning the treads of the wheels if the brake shoes are in proper position; but for various reasons the brake beam is not always central and one shoe may overlap the rim while the other crowds the flange.

The pressure on the shoe is not changed on account of its position, hence, when the bearing area is reduced the pressure and the resulting heat per square inch are increased in the same proportion as the bearing area is decreased. This accounts for the number of brake burnt rims and also for cracked flanges when the shoe bears heavily on the flange.

This condition is also quite likely to crack the plate of the wheel on account of the expansion at the rim while the tread of the wheel near the flange is cold, which produces a strong leverage, throwing the front plate into tension to such an extent as to sometimes cause the metal of the front plate to fracture for a distance long enough to reduce the pressure.

When a chilled iron wheel has become brake burnt and is kept in service, the subsequent pounding disintegrates the metal which drops out little by little and results in a condition called "comby from brake burn." This leaves the metal in a ragged condition, as the plane of cleavage is radial or perpendicular to the tread, and small particles of metal break off more or less irregularly.

In this connection, it is well to mention slid burnt wheels. When a wheel slides, an intense heat is generated almost instantaneously, and the metal is rapidly worn away, leaving a flat spot, often showing a fine network of hair cracks around the area of the flattened surface. This condition usually appears in spots about two inches long, either singly or at various parts of the same wheel. If the slid flat spot is not large enough to require removal and the wheel remains in service, the metal which has been disintegrated by the heat may break up and drop out, resulting in a condition known as "comby from sliding."

Shelled Out Wheels—The term "shelled out" refers to spots on the wheel where the metal has dropped out from the tread in such a way that a raised spot is left in the center, with a cavity more or less circular around it. In this case, in addition to the radial lines of cleavage, there appears a holding element of the particles making the wheel parallel to the surface of the tread, and, therefore, the bottom of the defect is more or less smooth, somewhat resembling an oyster shell.

The cause of shell outs does not seem to be as self-evident as that of comby wheels. The conditions which exist and give rise to shell outs will, therefore, be described in detail. The maximum air brake pressure is adjusted for the light weight of the car, hence wheels are not as likely to slide under loaded cars. Sliding often occurs just before a train comes to a standstill. This is occasioned by the greater efficiency of the brake shoe as the speed of the train decreases. The greatest frictional resistance between the wheel and the brake shoe occurs just as the wheel is about to stop revolving and often at this point exceeds the frictional resistance between the wheel and rail, in which case the wheel begins to slide. After the wheel once begins to slide, the friction between the wheel and the rail is very much lessened and sliding will continue until the brake pressure is reduced.

When the sliding is over a distance of only a few feet before the car comes to rest, the term "skidding" is applied and a small skidded spot the size of the area of the wheel in contact with the rail is produced. A flat spot no larger than the contact area shown is not sufficient to cause the removal of the wheel, but the subsequent blows received in regular service very often result in the metal breaking or shelling out around the surface of this contact area, forming a shelled out spot.

During the time the wheel is sliding, all the mechanical energy represented in the resistance to motion is transferred into heat through the agency of friction; and as mechanical energy and heat are mutually convertible, the exact amount of heat generated can be easily calculated and it is a matter of common observation that often the melting point is reached.

Cracked Plates—The question of cracked plates is another matter deserving serious attention. The primary cause of cracked plate wheels is an expansion stress, due to sudden heating of the tread while the plates are cold. When the brakes are applied continuously, a rapid expansion takes place in the metal of the tread which produces a strong tensile stress on the plates. Usually the heating is more severe toward the rim, and, therefore, there is a greater stress on the front plate than on the back plate.

In addition to the temperature stresses, the flange pressure reacts on the plates, producing a tensile or pulling stress on the front plate, and a compression on the back plate, hence the combination of stresses on the back plate

tends to equalize each other. Too much care cannot be exercised by inspectors to locate cracked plate wheels, as they are a source of tremendous danger in service.

Worn Through Chill—The defect known as worn through chill cannot often be discerned by the appearance of the tread and manner in which it is worn. If worn irregularly, that is, deeper at some places than at others, or if worn flat, it is evident that it has worn through the chill. Wheels seldom wear through the chill all around the tread at the same time; therefore, when a wheel is worn evenly, no matter how deeply, or shows the shape of the rail all the way around (commonly termed "railworm"), and has no appearance of being worn flat at any place, there is a good reason to question whether it has worn through the chill. This can be determined by polishing the tread with emery cloth, breaking off the flange with a sledge, denting the tread with a chisel, or breaking the wheel. When the first method is used, if a few small black dots of graphite can be seen, the wheel is just starting to wear through the chill. If the graphite shows plainly, it is well worn through the chill.

A method in vogue with some railroads is to dent the tread with a chisel, and if the chisel makes a deep mark without blunting its edge, the wheel undoubtedly is worn through the chill.

Tread Worn Hollow—The amount a wheel shall be worn in the tread to warrant its removal from service is left largely to the judgment of the car inspector. The idea is that wheels should be removed when worn sufficiently to permit the rim to project far enough below the top of the rail to render it liable to breakage when passing over frogs, or when the flange becomes so high that its end is likely to strike the bottom of flange ways. When wheels are worn excessively hollow, damage is done to the track at frogs and crossings on account of the overhanging rims and the high flange, which causes excessive pounding, resulting in rapid deterioration of the track at these points and often breaking off track bolts. It is the practice in track work to allow a minimum of 5/8 in. for flange clearance at the bottom of flangeways in frogs, crossings, guard rails, etc. This allows for the tread to wear down 5/8 in. before the flange would strike the frog and crossing fillings on new rails. It is customary in the heavier rail sections to allow more than 5/8 in. below the end of the flange. This is a matter which needs attention locally to meet the daily requirements of service.

The minimum amount a wheel shall be worn hollow is not specified for freight service, but is generally conceded to be 3/16 in. Some railroads recommend that wheels be allowed to wear down 5/8 in. before condemning them, unless worn through the chill.

Worn hollow is the legitimate condition of worn out wheels. In the lighter capacity cars, the percentage of wheels removed for this cause is large, while in the heavier capacity cars flange wear is greater and also all of the heat defects are in greater evidence, hence the percentage of worn tread wheels is reduced. Wheels which crowd the rail on one side or the other should be very carefully observed. Complete sets of suitable wheel gages with complete instructions are sent to any station on the system making request for them.

Guarantee on Cast Iron Wheels—It is occasionally necessary to purchase wheels from outside concerns. This material is purchased under the guarantee shown in the table below, and where renewals are made within the period stated due to manufacturer's responsibility, claim must be made for replacement, all cases being fully written up to the master car builder and the wheels held for disposition. Wheels manufactured in the railroad company's foundry must be checked up just as severely and any failure in service reported in the same way and the wheels held for examination.

Wheels which fail to render this service on account of any defects in material or workmanship will be replaced free of cost to the railroad upon delivery of the defective wheels at the works. The wheel makers do not replace wheels which fail to render the guaranteed service on account of flange wear nor wheels removed *in pairs* on account of shelling out.

Cast Iron Wheels, Guarantee

Size of wheel	Weight	Axle	Capacity	Number of years' guarantee from time date marked on wheel
33 in. diameter....	625 lb.	4¼ in. by 8 in.	60,000 lb.	6 years
33 in. diameter....	700 lb.	5 in. by 9 in.	80,000 lb.	5 years
33 in. diameter....	725 lb.	5½ in. by 10 in.	100,000 lb.	4 years

AN INTERESTING CHAPTER FROM AMERICAN RAILROAD HISTORY

"The Portable Boats of Early Railroad Practice" is the title of an article written by J. Snowden Bell and recently published by the Baldwin Locomotive Works in the form of a booklet included in the Records of Recent Construction (No. 97). The book describes what in the 30's was referred to as "the great transportation system" extending from Philadelphia to Harrisburg. This was principally a canal route connected by stretches of railway for which Mathias Baldwin constructed the early locomotives, and which later was absorbed by what is now the Pennsylvania railroad. The first pages relate the entertaining narrative of a pioneer who crossed the Alleghenys with the first portable boat and made his way down to the headwaters of the Mississippi. This boat was not designed as a portable affair, but was intended to be sold on his trip west when he reached the point at the foot of the mountains where rail transportation replaced the canal barge. It was found practicable, however, to cut the boat in sections, load it onto flat cars, and thus transport it over the mountains. This led to the construction of many sectional boats, the details of which, together with the cars specially constructed for this service, are well described and illustrated with some of the very early patent drawings covering these conveyances.

The Baldwin Locomotive Works deserve credit for giving wider circulation to a phase of American Railroading that is fast slipping into obscurity, and are fortunate in securing the authorship of Mr. J. Snowden Bell. It is hoped the publication of this fascinating page from early American history will lead to greater publicity concerning American railroads in the making.

Photograph from Underwood & Underwood, N. Y.

A Passenger Train in India

Cost Accounting—The Key to Cost Control

A Discussion of the Advantages of Cost Keeping with a Description of a Typical System

BY GEORGE W. ARMSTRONG

CONTROL of industrial operation requires a panorama, a perspective bird's-eye view of the multitudinous activities of that industry. Effective control requires more, it requires an intricate, digested knowledge of the details of those activities; requires a knowledge as to the equivalency of return for expenditures to successfully avoid the wastes which cannot otherwise be detected.

Railroad accounting is clearly defined by Interstate Commerce Commission regulations. This uniform classification of accounting, aside from any inherent merits or defects, serves the purpose for which it was designed. It furnishes, indeed, statistical data of the most valuable kind for the railroad executive in charge of the property, for the investor and for the regulating commissions. But the reports of railroad operation as a whole fail to throw light on the details of its productive activities.

Cost accounting is concerned with the details of these primary accounts in railroad operation. One of the prime functions of cost accounting is to enable the executive in immediate charge to know details promptly. Records of cost by themselves do not effect economy, it is only by their proper presentation in convenient and convincing form to the executives responsible, that these executives can correct inefficiencies, pointed out by these records, through improvement in organization, administration and in individual processes and methods. The degree of refinement in a cost accounting system should not exceed that required to secure this result, i. e., effective control. The essentials of any cost keeping system are:

That it accurately account for materials and supplies purchased and given out.

That it charge labor to the work on which it is employed.

That it furnish an accurate check and distribution of overhead expenses or burden.

That it record facts and conditions and provide for current interpretation of their significance.

This discussion will be confined to the Maintenance of Equipment but it is not inapplicable to the other branches of railroad operation. The Interstate Commerce Commission Statistics of Class I railroads for the year ending June 30, 1916 indicate the expenses for Maintenance of Equipment to bear the following ratios to total operating expenses:

Maintenance of Equipment—Steam locomotive repairs, 8.017 per cent; freight train car repairs, 8.18 per cent; passenger train repairs, 1.563 per cent; total, 17.760 per cent.

Transportation—Engine house expense—yard locomotives, .506 per cent; train locomotives, 1.642 per cent; total, 2.148 per cent. Aggregate total, 19.908 per cent.

The summary of statistics for Class I railroads as issued by the Interstate Commerce Commission to December 31, 1918, shows that the percentage of operating expense applied to maintenance of equipment in 1918 was 27.73 per cent instead of 17.76 per cent as given above for the year ending June 30, 1916. The details of division to steam locomotives, freight train and passenger train car repairs, and for engine house expenses were not available, but the increasing magnitude of this branch of operating expenses can be visualized by the comparison.

The Function of Cost Accounting

Cost accounting with respect to these operating expenses should embrace sufficient detail to reflect accurately the distribution of expenditures, to insure quick analysis of details and furnish cost data for expert analysis as close as possible in point of time to the occurrence of the charge. Close relation between responsibility and cost is the active agency required for improving operation. Refinement of detail beyond what is necessary to provide data for effective control is not justified, but the absolutely necessary cost of control, whatever it may be, is worth the cost.

Results will not be secured from cost knowledge if confined solely to afterthought analysis. The cost agency should also embrace means to predict in advance results with respect to new needs based on past performances. Otherwise it will be impossible to avoid excessive expenditures in many instances for articles which can be more cheaply purchased. On a large trunk railroad recently, the need developed for a rather large number of pieces of a certain forging on Mikado type locomotives. An initial lot was made under the steam hammer, machined and applied. Analysis then developed that these parts cost from two to three times more for labor and material alone than better drop forged parts that could be purchased in the open market. Advance cost analysis would have determined this without the loss incurred in this instance. Similar examples can be duplicated daily in our railroad shop operation.

Cost accounting is needed in railroad operation today as never before. The prices of materials have increased, labor has doubled in cost, productive efficiency has lessened. The times demand that the trained finger of management maintain unbroken contact with the pulse of production.

Disproportionate relations existing between the labor and material components of shop operations compared with those existing in pre-war times may necessitate modifications in practices. Where under former conditions things could be produced economically, purchase may now be cheaper. Machine tools and shop facilities at one time adequate may have become utterly inadequate viewed in the light of present wages and restricted production. How can these questions be settled without the aid of an efficient cost accounting system?

Proving Economies

The superintendent of motive power of a large trunk line recently stated: "I am almost convinced that we should make everything possible for locomotive repairs at a central point, where we can install the best facilities and get the benefit of quantity production. Then we should make our repair shops simply dismantling and assembling shops, doing only what other work is necessary to repair worn parts." How are the roads to determine whether that should be their goal in the future, and whether it is productive of economies predicted, if not given the aid of an efficient cost accounting system?

It has been said figures do not lie. The corollary to this is that a true interpretation depends on accurate analysis. And if figures sometimes lie, they also talk. Many conditions are tolerated, inadequate and woefully inefficient facilities are maintained, practices are perpetuated because figures are not given their opportunity to talk. Cost knowledge is lacking to discern which is unprofitable, cost knowledge is not at hand to drive home to the railroad executive the true economy of improving conditions, facilities and practices.

E. J. Pearson, former Federal Manager, now President of the N. Y. N. H. & H. in the discussion of Mr. McManamy's

paper before the New England Railroad Club said: "There is no executive and no board of directors that knows about your old lathe . . . why at the Southville roundhouse . . . engines are being delayed and traffic is not handled, although they may know that traffic is not moving as it should. They don't know the particulars of your needs unless those who are on the firing line put the case in shape and submit it, and do it so concisely, clearly and effectively that it will compel consideration on its own merits.

"Every one financially interested in a railroad is interested in the service, but particularly in the dollars and cents that are left at the end of the month. . . .

"If improvements are advantageous and hence money makers, the cheapest thing that any railroad can do is to make them. If there is some improvement that will pay twenty-five per cent on its cost and money is worth six per cent, there is nineteen per cent of velvet right there. . . .

"I agree that improvements recommended by Mr. McManamy aggregate big if you get the right ones. There are many of these projects that are presented simply because they are a good thing and when analyzed are explained as being desirable, that somebody else has them, that they are modern, or for reasons equally intangible. Bankers do not finance on statements of that character, but they do understand clear, concise statements that prove you can make nineteen per cent velvet as a result of the undertaking. . . .

"The point I desire to bring home to all is the necessity of working out your case, proving it and of then presenting it understandingly. Reduce your proposition to the absolute necessity, the benefits, the savings and the advantages and put it in shape so that when it comes up to those who do not know the details of the mechanical business, but do understand net returns, and on whom in the final analysis we must depend to finance these needs, the situation is made clear to them."

A Plan of Cost Accounting Discussed

Bearing in mind the essentials of cost accounting and its crying need, it would be well to consider its method of accomplishment. The first question to be answered in determining upon a system is: What is cost accounting expected to accomplish on a railroad? Is it to secure a record of the exact cost of each shop operation, or to furnish an aid to production and a means of determining whether an equivalent return is secured for value expended? Obtaining a complete distribution of the time consumed by each workman on each operation will not solve the cost problem, but will result, the more complete and elaborate such distribution is, in getting further from the desired result. The only result will be a tremendous volume of detailed information practically impossible of digestion. This will neither serve as an aid to production nor a measure of equivalency.

Shop Distribution

The output unit for locomotive shop operation is the locomotive, but this for purposes of cost accounting is as much too unwieldy as the detailed distribution is too elaborate. For constructive analysis in directing operation, controlling and determining policies based on cost accounting facts, and for finding whether a proper equivalent is secured for money expended, labor and material distribution should be made to master classifications of work by key reference and locomotive number. A standard key, either using a mnemonic or figure reference used as a prefix to the locomotive number should be established. Provision should be made for checking labor distribution directly in the department and without imposing an additional burden on the foreman. Material orders should be issued by one or more men delegated primarily for that duty, thus insuring proper distribution as well as a check on the disbursement of material. The suggested divisions of charges would be

Engine Trucks.	Driving Boxes.
Cylinders and Guides.	Spring Rigging.
Pistons, Piston Rods and Crossheads.	Wheels.
Valves.	Trailer Trucks.
Valve Gear.	Rods.
Power Reverse Gear.	Steam Pipes.
Front End.	Air Brake Work.
Flues.	Cabs.
Frames.	Cab Fittings.
Lubricators.	Stoker.
Injectors.	Superheater.
Electric Headlight.	Brick Arch.
Boiler.	Tender Frame.
Fire Box.	Tank.
Grates.	Tender Trucks.
Ash pans.	Draft Gear.

Given such a distribution of charges, a standard can be established based on experience which will serve as a measure of equivalency without the recording of details. However, sufficient detail should be recorded as to operations, so that the data can be employed at a future date for compiling unusual cost data or checking marked variations. As an aid to production, working on a day work basis, details of operations together with time consumed should be recorded only if currently associated with a standard time basis of comparison. The record of efficiency thus furnished will only be of value if followed up close to the event.

In many shops, labor conditions, aside from the additional factor of the expense and waste of time, will demand that records be secured with the least disturbance of shop management. The simple, sensible way to handle labor costs is that advocated by G. Charter Harrison,* i. e., "to set time standards for each operation and instead of recording the time spent by an operator on every job he performs during the day to compare his total time for the day with his production figured in terms of standard time. Under such a method all that is required in the form of time clocks is a regular in-an-out clock recording the actual time spent on the premises, and a record of the work which the man produces."

The accounting for the material used should follow closely the same lines as the distribution of labor charges. It should do more, however; it should involve the installation of a perpetual inventory system for handling storehouse material, which should be accurately checked at intervals with actual storehouse stock. Adjustments in storehouse balances should be made systematically throughout the year, instead of at the time of a fiscal annual inventory. Care should be taken to keep adjustments to a minimum, accounting as accurately as possible for disbursements currently.

Distributing Overhead

A separate account should be opened in the shop expense ledger for the indirect expense in each department, leaving only that portion of the indirect expense impossible to definitely locate to be generally applied upon the whole labor payroll of the shop. This results in an accurate check and distribution of the overhead, and is an effective means of minimizing indirect expenses. The indirect expense thus allocated to a department should be applied to the direct labor of that department.

Effective control is insured by definitely allocating expense by fixing responsibility along department lines. This fixes individual responsibility and gives the department executive the means of telling whether his costs are high or low, as his labor cost is forecast by the group distributions.

All distribution of labor should be made daily, by departments and distribution balanced with the labor payroll of the department. Material distribution can be cared for at less infrequent intervals.

Engine House Distribution

The problem of accounting for engine house expenses is a different problem from that of shop operation. The ideal possibly would be allocating of expense pertaining to each

*Industrial Management, Jan., 1920, p. 13.

individual engine for purposes of comparison as between classes of equipment and determining the particular engine of a class which is disproportionately expensive because of some fault in repair or construction. However, dependable figures as to individual engines cannot be secured except at a cost not warranted by the value of the results. It would require a force at each terminal to check each workman on and off each job, and it would not serve any more useful purpose than could be accomplished in a simpler way.

Engine house expense should be distributed as to labor and material to major divisions of maintenance work, in addition to the terminal operations, for example:

Front Ends.	Spring Rigging.
Cylinders.	Wheels.
Valves.	Cab Work.
Valve Gears.	Stoker.
Air Brake Work.	Superheaters.
Rods.	Tanks.
Boiler.	Brick Arches.

Subdivisions as refined as those employed in shop operation are not required but sufficient subdivisions should be made to give useful checking groups as between terminals as well as judging the efficiency of the particular terminal at any time. These subdivisions would follow closely the assignment of workmen, and so would involve a minimum possibility for error, even if the workman was depended upon for time-card distribution.

Lorain K 801

30M (A 10m) 10-1-18—22x34-26c FORM 2426

UNITED STATES RAILROAD ADMINISTRATION

W. G. McADOO, DIRECTOR GENERAL OF RAILROADS

BALTIMORE AND OHIO RAILROAD

MOTIVE POWER DEPARTMENT.

Mt Clare *Station,* 8-16 191 9

Mr. F. Paulis

Please furnish 200 Major Knuckle Pins

1 5/8 A - 12 1/2 B - 13 1/4 C

17220 E - 25 G

Finegan Isaac

Charge Cost to S. O. 80356

When ready, notify me by attached Coupon.

Form of Material Order

An approximately accurate analysis of costs for different classes of power could be secured from these subdivided costs by equating them on the tractive power mile basis or ton mile basis for the division.

Having considered the abstract needs for cost accounting, and a theory as to application, it might in conclusion be interesting to analyze a system embodying many of the essential features which is in actual use on the Baltimore and Ohio Railroad at their Mont Clare, Baltimore, Md., shops.

Cost Accounting Concretely Applied

This description relates to the shop order system used for following all foundry, forge shop, spring shop and manufacturing machine shop work, in fact everything except the work directly applied to the dismantling and repair of locomotives and cars, which is charged in total to individual locomotives, and passenger train and freight train car repairs, which are handled in the usual manner. A great portion of the material required for locomotive and car repairs, however, is finished for stock and consequently represents a material charge, reducing to a minimum the labor charge distributed as a blanket charge to locomotive, passenger or freight car repairs.

25m-(a8m)-7-21-19 Form 1059 C

UNITED STATES RAILROAD ADMINISTRATION

DIRECTOR GENERAL OF RAILROADS

Baltimore and Ohio Railroad	Western Maryland Railroad
Coal and Coke Railroad	Cumberland Valley Railroad
Morgantown and Kingwood Railroad	Cumberland and Pennsylvania Railroad

Dayton and Union Railroad
Dayton Union Railroad

Shop Order Number 80356

Material For Lorain

Requisition K 801

Date 8-16-19

orig Foreman Finegan

Card to Isaac

COMPLETE THE FOLLOWING MATERIAL

200 Major Knuckle Pins

1 5/8 A - 12 1/2 B - 13 1/4 C

17220 E - 25 G.

Pattern Number

Blue Print

Class

Completed ______ Foreman

Received ______ Storekeeper

Card No. 1 Line 7

Work Order for Individual Departments

Shop Order Department

All individual shop orders are originated in the storekeepers' office on form 2426, original and duplicate, and

sent to the office of the assistant to the shop superintendent who is in charge of the shop order office. Monthly shop orders are used for certain regular work, i. e., brass foundry, iron foundry, spring repairs other than locomotives undergoing repairs at the shop, bolt forgings, steel car repair parts flanged, shop machinery and tools, etc. For these classes of work a regular shop order number is definitely

Form 1433-B

Rings No 440 Retainer a 15239, BP 36380 - Card #1

S. O. Number	Quantity Ordered	Date Issued	Req. No.	Number of Pieces Made and Date						Average Cost Each	Date Closed
60103	500	6-1-18	stock	36 / 6-17	68 / 6-18	101 / 6-19	134 / 6-20	167 / 6-21	195 / 6-22		
				225 / 6-23	259 / 6-25	292 / 6-25	316 / 6-26	434 / 6-27	500 / 6-29		6-29-18
10067	1000	1-2-20	stock								

Master Record Card

fixed, which in reality becomes an account number. The shop order number assigned by the storekeeper is keyed to denote the month in which it is issued. This is denoted by the ten thousand group in which the number occurs, thus 10,067 is a shop order issued in January, 30,152 a March shop order, and so on.

On receipt of the material request form 2426 by the shop order office it is marked on the face with the names of the foremen of the departments upon which it is issued. The duplicate is then sent to the accountant's office and the original retained in a file in the shop order office until the shop order is completed when it is also sent to the accountant's office, properly marked, denoting the closing of the shop order.

When form 2426 is received, form 1059-C is made out to the foremen of the various departments. This card gives all

150M—(A50M)—4-18-18—24 34x36 Form 1124 B

THE BALTIMORE AND OHIO RAILROAD COMPANY

FOREMAN'S WORK ORDER

From Storehouse Shop To Automatic Shop

Charge 10067 Date 1-9 1920

QUANTITY	TO MAKE OR REPAIR
50	a 15239

Finegan Foreman

Work Completed ______ Workman

NO MATERIAL TO BE FURNISHED ON THIS CARD

Foreman's Order for Material for Shop Order

information necessary to finish and deliver the work. In the event of several departments being involved, each foreman receives a copy marked over "foreman," original or copy, the original always going to the foreman completing the work, the item "card to" showing all the departments he must depend upon to perform initial operations on the material.

At the same time form 1059-C is issued, the shop order

3000M—(a1000m)—1-25-19—24x34—150 Form 2411

No. 3 Shop Mont Clare

UNITED STATES RAILROAD ADMINISTRATION, Director General of Railroads, BALTIMORE & OHIO RAILROAD—MATERIAL CARD.

Charge 50 10067 Date 1-9 1920

QUANTITY	Pattern No. or Size	DESCRIPTION	New or 2nd Hd	Classification	DEBIT Weight	DEBIT Price	DEBIT Amount	CREDIT Weight	CREDIT Price	CREDIT Amount
50	a 15239	Retainer Rings	new					125#		

Enter on each Card Items Chargeable to One Account Only
Specify in proper column for each item whether material drawn is NEW or SECOND-HAND.

F. Paulli's Foreman

Shop Order Department's Material Order on Storehouse

50m-(a15m)-10-2-19 24 38 40 Form 1061

UNITED STATES RAILROAD ADMINISTRATION
DIRECTOR GENERAL OF RAILROADS
BALTIMORE AND OHIO RAILROAD

SHOP ORDER CREDIT SLIP

S. O. 10067 Date 1-8-20

Stock

50 a 15239 Retainer Rings, BP 36380

Inspected and counted by Finegan

Received at Storehouse H. Shoemaker

Form for Transfer of Material

number, quantity order, date issued and requisition number is entered on the master record card, form 2435-B.

After the receipt of form 1059-C, as the foreman requires material for the finishing of the shop order he issues form 1124-B on the shop order department, which then originate form 2311 on the storehouse and material is delivered by motor truck dispatch. A record is kept on a mimeographed form of shop order material distribution sheet assigning a serial number with suffix number for each material order issued. Thus is insured an accurate account of all material used in completing the shop order, as well as giving the accounting bureau a check, because if the last material order received bears suffix 20 and numbers 12 and 16 are missing they must be looked up before the shop order is closed.

In connection with the use of form 2311 it is interesting to know that these are safeguarded as if they were checks

Form 1059-A

Hangers-Brake Beam 7/8" x 10-7/16, N-8 BP14681 Card 1 11603

DATE ORDERED	AMOUNT ORDERED	NUMBER OF PIECES MADE AND DATE									TOTAL
9-9-13	200	100 / 9-16	200 / 9-29								200
11-8-13	300	300 / 11-19									300

Master Record for Monthly Shop Orders

payable to the bearer. The number stamped at the top of form 2311 in the general foreman's office identifies the issuing foreman to whom this number is assigned. The signature used in conjunction with the identifying number must correspond with the authorized signature filed in the storehouse.

Each transfer of material from one department to another, or to the storehouse is made by means of form 1061, which must accompany each transfer and be signed in the department receiving the material, returned to the issuing department and sent from there to the shop order department. When form 1061 is received for finished material delivered to the storehouse, it is immediately recorded on the master card form 2435-B. In this way, the shop order department is continually appraised of the status of all shop orders relative to material ordered for work in progress, the status and location of work in progress and the amount of work completed to date. The foreman also keeps a daily record

PATT No. a 1523 TITLE Collar CARD No. 1

LINE No.	NUMBER ORDERED	DATE	NUMBER OF CASTINGS MADE AND DATE												TOTAL
1	12	10/8/18	2 / 12-9	4 / 12-10	6 / 12-11	8 / 12-12	12 / 12-13								12
2	25	12/4/18	2 / 12-13	6 / 12-14	8 / 12-15	14 / 12-17	18 / 12-18	22 / 12-19	25 / 12-20						25
3	50	1/5/19	2 / 1-9	6 / 1-10	8 / 1-13	10 / 1-15	12 / 1-22	14 / 1-23	16 / 1-24	18 / 1-25	20 / 1-27	22 / 1-29	24 / 1-30	30 / 1-31	
4			35 / 2-4	41 / 2-5	45 / 2-6	47 / 3-1	48 / 3-3	50 / 3-8							50
5	150	11/14/19	Purchased on Req. a 11065												
6															

Foundry Master Record

on the back of form 1059-C, so that he is also in possession of information showing the status of the shop order, until it is completed when he returns it to the shop order department signed and dated.

Forgings and foundry output are handled on monthly shop orders as previously indicated. Forgings, bolts, springs and steel car parts are ordered by the storehouse twice a month, special stock oftener. As soon as the order is received it is entered on master card form 1059-A and form 1059-B issued to the foreman. A serial number is stamped on the end of form 1059-A used for filing and ready reference. This serial number also appears on form 1059-B and form 1061, as issued.

The foundry work is also handled on permanent yearly shop orders. Each morning the storehouse advises the shop order office of castings required. Immediately form 1085 is issued on the foundry and also entered on the foundry master card. A copy of form 1085 is also kept on file in the

UNITED STATES RAILROAD ADMINISTRATION, W. G. McAdoo, Director General of Railroads.

25m. 8-7-16. Form 1059-B.

Baltimore & Ohio Railroad Co.

11-8 1913

Isaac
Foreman.

Will manufacture the following material, and charge the labor and material to 244506

DESCRIPTION

Hangers-Brakebeam 7/8 x 10-7/16
N-8
11603

Blue Print 14681

Class

Completed
Foreman

Received
Storekeeper.

Card No. 1 Line 2

Work Order for Monthly Shop Orders

shop order office for convenient ready reference. These cards are kept filed by weeks and unfilled cards are set back each week, so that not only do they serve the purpose of showing what is due, but also how long due. This aids in expediting the oldest orders.

The foundry is the only department where form 1061 is not used, the record of work completed here being taken from the inspector's daily record of castings delivered to the storehouse casting platform.

Accounting Department

When form 2426 is received by the accounting department, a master record card form 1195 is made out indicating not only the essential material references but also the department references.

Each day's labor distribution is taken from the service cards form 2453 Rev. being entered by departments onto mimeographed distribution sheets. As the distribution is taken off, the service card number is noted as well as the

hours and amount. Each distribution sheet is then balanced against the total hours and the amounts extended noted in pencil on the top of the service cards. Of course, it is often impossible to secure an absolute balance but the variation is kept to a minimum. The daily distributed labor charges are then entered on form 1195 back under the respective departments. If it is found that the department does not appear as an authorized department it is returned to the shop for correction or authorization by the shop order office.

At the end of the month the distributed totals are added and the proper percentage added to cover supervision and unclassified labor charges. This percentage is based on the total of the shop orders and classified labor charges from daily distribution sheets and is the labor charge for supervision, cleaning the shop, checking in and out, etc., for the respective departments.

The material charges are made up about three times a month from form 2311 summarized on a mimeographed sheet, balanced against total of form 2311 and then entered on the respective master record cards form 1195 before filing.

At the end of each month the shop expense (denoted ME) is figured and entered on the card form 1195. This is determined by taking the prorated total of unclassified shop expenses based on the previous month's labor charge for maintenance of equipment and shop orders to fix their respective divisions of the shop expense. The proportionate shop expense thus arrived at is distributed on the basis of the actual labor charge in the proper month.

Twice during the month and at the end of the month, a list of individual shop orders closed is sent to the storekeeper giving quantities, description of material and charge. All unfinished shop orders are balanced and totaled at the end of the month for clearing on the shop report.

The experience of this one road bears out the belief that cost knowledge is essential to control shop operation. The total of $1,094,825,873 for maintenance of equipment expenses for the Class I railroad during the year ending December 31, 1918, emphasizes the possibilities of even slight improvements, 1 per cent saving being $10,948,258. Cost knowledge which can only come through cost accounting and cost analysis is one of the most important agencies that can constructively assist in bringing about improvement in railroad operating costs. The Federal Trade Commission estimates that 25 per cent of the businesses of the country fail through lack of accurate cost knowledge. Who can say how much of the present waste through inefficiency in railroad operation is due to the same cause? An awakened cost consciousness on the part of management is the one great hope for bettered operation; for that awakening will lead straight and inevitably to improved facilities, organization and equipment.

UNITED STATES RAILROAD ADMINISTRATION
W. G. McADOO, Director General of Railroads.
20M—1-4-18. 28x45—190 Form 1085.

B. & O. R. R. CO.
E

CASTINGS ORDERED AND MADE

1-5 1919

Pattern No. a 15123

Pieces Required 50

Title Cellar

Card No. 1 Line No. 3

NUMBER OF PIECES MADE EACH DAY

Storehouse Order for Castings

SHOP ORDER MATERIAL DISTRIBUTION SHEET

SHOP ORDER NUMBER 10067 DATE ISSUED 1-2-20 REQN.NO. Stock

ISSUED ON Finegan

FOR 1000 # 440 retainer rings Pat # 15239

DATE	QUAN. ORD.	DESCRIPTION
1-5	50	a 15239 Retainer rings (125#) O10066
1-8	50	a 15239 " " (125#) O 10066-1
1-9	50	a 15239 " " (125#) O 10066-3

Summary of Material Charges

Form 1195

COMMENCED 8/16 1919

COMPLETED ______ 191__

SHOP ORDER NO. 80356 FOR 200 Mayor Knuckle Pin HOW CHARGED Storekeeper

1 7/8 a - 12 1/2 B - 13 1/4 C 17220 E-259

REQUISITION Lorain K-801 ON Finegan, Isaac SHOP

DATE		MATERIAL Gross	MATERIAL Credit	MATERIAL Net	LABOR	TOTAL	DATE	AMOUNT
Dec.	19	98 40	12 00	86 40		86 40		
	19	ME 21 03		21 03	105 16	126 19		
					Bal	212 59		

Dec	Smith	Automatic	Bolt & Forge
22		7 22	
23		12 26	
26		13 73	
27		12 26	
29	1 72	8 58	1 72
30		49	
31		20 16	
Sup		3 68	
	1 72	78 38	1 72
	25	22 81	28
	1 97	101 19	2 00

Accounting Department Master Record (Front and Back)

AMERICAN WELDING SOCIETY HOLDS FIRST ANNUAL MEETING

The American Welding Society held its first annual convention in the Engineering Societies Building, 33 West 39th street, New York, on Thursday, April 22. The morning session was devoted to society business and announcement was made of the election of officers. J. H. Deppler was elected president, J. W. Owens was elected vice-president for two years, and D. B. Rushmore was elected vice-president for one year.

A plan of action for the American Bureau of Welding for the coming year was discussed at the afternoon session. It was proposed to reduce the representation of the American Welding Society in the American Bureau of Welding. A committee was authorized to lay down a scheme of organization and to prepare a program for the coming year.

Comfort A. Adams, chairman of the bureau, spoke briefly on the subject of welded joints for pressure vessels. A point of particular interest was brought out in this in connection concerning the use of different kinds of welding machines. Mr. Adams showed that within the limits of arc length consistent with good practice in electric welding, it made no difference whether the machine used was a constant current, constant heat or constant unit heat machine.

Mr. Adams' statement was in effect as follows: In the case of the constant heat machine the current is decreased as the arc is lengthened. The constant current machine maintains a constant current for any length of arc within the limits of the machine. In the case of the constant unit heat machine the current increases as the arc is lengthened. Owing to the fact that the arc spreads out and covers a greater area as it is lengthened it is necessary to increase the current to maintain a constant heat per unit area. Theoretically this would be the ideal machine, but within the limits of arc length consistent with good practice, the variation of current is practically a negligible quantity.

The objective of the bureau's activities will be to determine how a good weld can be assured. Methods will be sought for testing the quality of a weld after it is made and for determining the best way of eliminating locked up stresses in long welds. At present the greatest hope lies in controlling the conditions under which the work is done. This will greatly reduce the amount of nitrogen in the weld. Heat treatment is beneficial in that it tends to break up the combined nitrogen.

The afternoon session was concluded by an announcement that a number of manufacturing companies have offered to assist the bureau with its research work. Much of this work is in a partially finished condition.

Speed of Metal Arc Welding

At the evening session, three papers were presented and discussed. The first paper presented was "The Speed of Metal Arc Welding," by William Spraragen, of the department of electrical engineering of the University of Washington. On account of the absence of Mr. Spraragen, who had been called away to the Pacific coast, the paper was read by E. A. Miller. In substance the more important portions of the paper are covered in the following statements:

The welding operator is a most important factor in successful arc welding and, of course, the more skillful the operator the more and the better work will be turned out. It is very desirable to be able to compute the rate at which arc welding may be accomplished, but the complexity of the different elements entering into it are such that it is very difficult to calculate the time required to produce certain kinds of joints. For inside work, 1.8 lb. of metal deposited per hour is a reasonable estimate, but when the work is performed outdoors there appears to be a reduction in the amount of metal deposited so that the average appears to be 1.2 lb. of metal deposited per hour for outdoor work. This reduction in the amount of metal deposited is probably due to the cooling action of the air.

With reference to the type of welding apparatus used, whether it be alternating current apparatus or direct current apparatus, it is estimated that where first class welding operators are employed there is no difference in the speed between the two kinds of equipment.

In a few words of explanation the retiring president, Comfort A. Adams, explained that the paper on the speed of arc welding was based upon conclusions arrived at by tests made by the General Electric Company in welding up some 10½ tons of welding material. This work was done just prior to the signing of the armistice and while the work had been cut up into coupons, ready for testing, the tests have not been made up to the present time.

Automatic Arc Welding

The second subject for the evening was "Automatic Arc Welding Machines," by H. L. Unland, of the Power & Mining Engineering Department of the General Electric Company. Mr. Unland stated that the automatic control of arc welding was not new. He said that the automatic arc welding machine had been developed for the reason that it was desirable in turning out large quantities of duplicate parts to make this operation as nearly mechanical as possible. As a precedent he mentioned that years ago the General Electric Company had developed a similar machine for a gas cutting process which was used in the making of small gears, wheels, etc. Operators, cutting by hand, frequently ran over the line; these factors influenced the company to take up the question of mechanical feed and a satisfactory cutting torch was eventually produced. At that time it was found that the gas consumption was reduced to one-third and that the speed was increased four or five times over hand work.

The development of the automatic arc welding machine is merely an extension of the same principles into another field and for sections that are being turned out continuously the mechanical feed is the proper thing to use. Mr. Unland described the General Electric machine and with the aid of numerous stereopticon slides explained very carefully the operation of the various circuits used in the control of the welding wire to the work.

Gas Cutting

The third paper on Recent Development in Gas Cutting, by Stuart Plumley, of the Davis Bournonville Company, was not read, but Mr. Plumley spoke briefly of the more important developments. The most successful development has been the cutting of cast iron with the gas torch. Cutting cast iron is particularly difficult because the oxide of iron melts at a higher temperature than the iron itself. The cutting is now accomplished by preheating the oxygen.

It is so easy to break cast iron that gas cutting is not often desirable, but it can be used to excellent advantage for such operations as cutting a frozen blast furnace cap.

Discussion

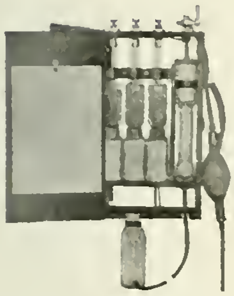
The discussion brought out the fact that the rigid method was used for welding tanks with the automatic electric welding machine. The statement was made that locked-up stresses were greatly reduced by reason of the fact that the speed of welding was very high. It was further stated that alternating current cannot be adapted successfully to automatic welding as a sensitive variable speed motor is required for feeding the metal into the arc.

Training of welding operators with the alternating current arc was advocated on the ground that because the alternating current arc had to be held within closer limits, the welders trained to use the alternating arc make better operators than those who receive their initial training with the direct current arc.

Economy at Stationary Boiler Plants

Some Loose Practices Common to Railroad Boiler Plants and What May be Done to Correct Them

BY C. M. ROGERS*
Service Manager, Locomotive Firebox Company, Chicago



THE operation of stationary boiler plants has been brought under the scrutiny of government, owner and manager in the past few years on account of a sudden well-founded realization of plant inefficiency; that in their condition as found they represented a tremendous drain upon the treasury of the operating concern, and that in the main they have fallen behind other institutions in the swift race of progress. It was also realized that these conditions could be remedied by an expenditure of time or money, or both, that would be quickly repaid by the economy effected.

The boiler plant is a producer, and should be so considered. Experts working on shop management are interested in increasing shop output and reducing cost of manufacturing their product, money is freely spent in every way imaginable upon shop improvements and much time is devoted to the study of shop methods. Production is right next door to the manager of a manufacturing establishment and is the object of his closest attention. It haunts him. The production of power required to operate a shop is obscure. Usually power is obscurely transmitted to the shop. The boiler plant is nearly always placed in a location separate from the main shop. The manager usually is appointed to his position because of his knowledge of shop work, and these men have seldom had occasion to familiarize themselves with the construction, operation and output of a boiler plant. Because of this obscurity and the concentration upon shop output, stationary boiler plants, as a rule, have been permitted to worry along with little attention until they are almost exempt from consideration as producers and are classed as a necessary evil. From the standpoint of production, they have been separated from the work of the shops to which they deliver power. As a result of this attitude plants are usually found in poor physical condition and employees assigned to operate them are not trained to a very high degree unless they have sufficient initiative to inform themselves and thus advance the interest of the company by improving operation as far as possible through their own efforts.

This general attitude exists towards plants up to 1,000 boiler horsepower. In recent years boiler plants of great capacity, representing the investment of huge sums of money and requiring large expenditures for fuel and other supplies, are receiving the most minute attention to maintain them in the best condition and to operate them as economically as possible.

A stationary boiler plant is fundamentally designed to bring together air and fuel in such a manner as to create combustion, the heat from which is to be converted to power through the medium of water. In order to maintain combustion the application of the ingredients must be controlled. To control the air the boiler is surrounded by a casing such as a brick setting. The fuel is controlled by the operator, either by hand or by mechanical means. As control of the air supply is essential, it should be made absolute by having the setting air tight in every respect. Air should be admitted to the fire principally through the grates, so that proper mixture of the ingredients may take place. After going to the expense of providing facilities for burning fuel it is folly to permit cold air to sweep through the chinks in a poorly maintained setting to reduce the temperature of the products of combustion, thereby losing heat that would otherwise be absorbed by water in the boiler. Admission of the proper proportion of air under the best conditions is very inaccurate, but when cold air is permitted to pass through the brick work and other crevices the resulting losses amount to a larger percentage.

Plants may be found today where the operator controls the supply of air by means of the ash pit doors alone, leaving the smokestack wide open to emit large quantities of heat. If corrected he states that with the ash pit doors closed there is no pull through the fire, consequently the heat will not be lost. At the same time his setting is without plastic cement, brick work is full of small cracks and the fire doors do not fit. The head of air produced by the difference between atmospheric pressure outside the setting and a partial vacuum inside causes cold air to stream through these openings, cooling the gases and carrying heat off through the stack. Firemen and others are familiar with the use of a damper in the stove pipe at home, and they realize that to leave the damper open at all times is a wasteful practice which is directly reflected in the amount of their fuel bills. A damper in the breeching or smokestack of a boiler plant performs the same function as the stove damper, but the men in charge fail to realize this fact and drift along sometimes for years baling in coal during periods of light as well as heavy load.

One can find many plants equipped with stack dampers, but the fireman doesn't know they exist, not to mention the fact he does not use them. There are stack dampers installed in such a manner that it is necessary to get a ladder to climb up on top of the setting in order to adjust them; then they are usually found to be inoperative. Damper operators should be simple, easy to operate, arranged for close adjustment and located at the position where the fireman works—at the fire door—so that he can make frequent adjustments to suit load, fuel and other conditions. The fireman should be shown that by utilizing the damper his labor is reduced and he saves on the fuel bill. When he once proves this fact to his own satisfaction he will use his mind to save his muscle and ever after will be a booster for any project intended to save coal.

As a rule firemen are too industrious. They shovel coal as a matter of dull habit and seem to be contented with handling large quantities of fuel, with no thought of the various methods of helping themselves by reducing the quantity.

Most plants have variable loads. Some of them are required to respond to quick changes of load in rapid succession. Others perform to their capacity during the day shift and are to a large extent relieved during the night shifts. Still others have the load reduced to such an extent during the night that fires may be banked. The writer has in mind a pair of hand-fired boilers totaling 400 hp., which were without stack dampers and were operated with the ash pit doors wide open at all times. Every afternoon at four o'clock the load is reduced about 75 per cent; but the ef-

* Mr. Rogers was formerly supervisor of stationary boiler plants on a western railroad.

forts of the fireman to keep up steam were reduced only about 15 per cent; the difference gives an idea of the amount of fuel being wasted. After dampers were installed a thorough demonstration of the possibilities of damper regulation of draft was made for the fireman on each shift and instructions given to follow this practice for a while to determine for themselves its value. Looking in on the fireman on duty at five o'clock one afternoon about a month later, both dampers were found in nearly closed position, the place cleaned up and the fireman spending most of his time lounging on a "lazy back" smoking a pipe. He was fully convinced that dampers were an improvement and was quite elated over the reduction in labor he had to perform. The CO_2 content of the flue gas at this time averaged 13½ per cent, which is a good figure for a plant of this kind.

If the damper is operated automatically by an effective appliance the very best results may be obtained. Such an operator should, if possible, be controlled by the pressure of air within the furnace, thus admitting only the required amount of air for proper combustion. An average of 15 per cent CO_2, representing perfect combustion, is possible with such an appliance.

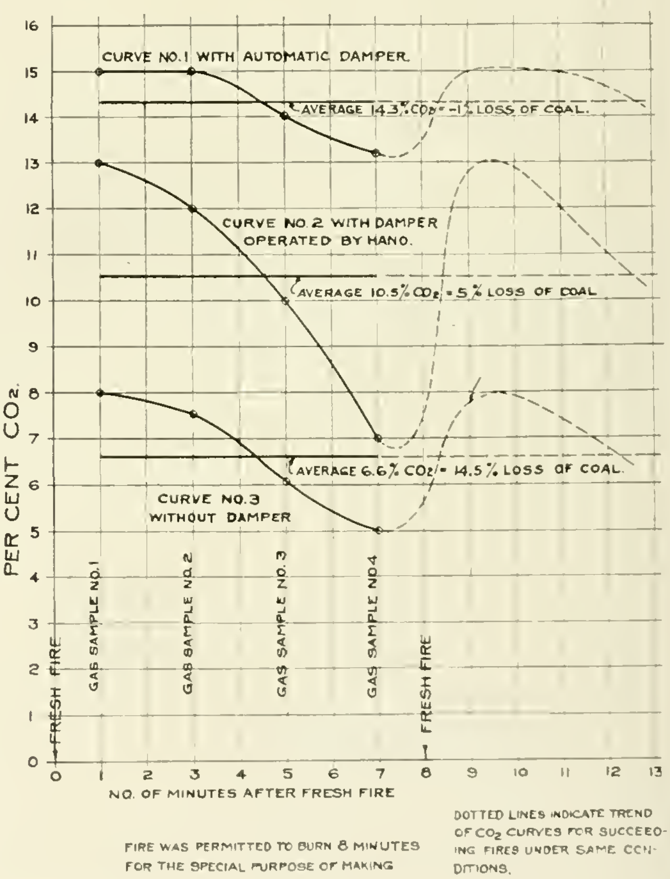
The owner of a plant is under obligations to install suitable equipment and appliances if he expects his employees to become interested in economical operation, and once installed, co-operation should be expected of the men. The best way to get next to the men is to don the uniform of the fireroom and demonstrate the truth of your instruction by doing it yourself, if you can, to prove it. A supervisor wearing a white collar cannot overcome the deep-rooted though misplaced conceit of most firemen that they know all about the game. Actual demonstration of how the job should be done, reinforced at times by a little authority, will convince them nearly every time. There are some old timers who have followed the game too long in the same old way to change their habits. These men should be given less important work if they cannot progress.

The use of a portable gas analyzer will accomplish a great deal in educating firemen. By the use of this instrument the writer has convinced many firemen of the error of their methods. At the outset an explanation of how the instrument makes its simple analysis should be made; this arouses interest. A series of tests with the damper in various positions, with fuel bed in the same condition, indicates the kind of combustion they are getting. The important point is to find the position of the damper that will result in the highest percentage of CO_2 (carbon dioxide), at the same time maintaining the required steam pressure and avoiding excessive clinker adhesion to the grates. Using the boiler front or other convenient surface as a blackboard, the results should be chalked up for a lasting impression on those interested. If, with the damper wide open, analysis indicates a content of 6 per cent CO_2, the 17 per cent preventable waste of fuel should be shown, next the corresponding amount of coal in tons based upon the monthly consumption, and then the cost. If, with the damper partially closed, the CO_2 content of flue gas is raised to 11 per cent, the reduction of preventable waste to about 4 per cent should be noted, and if the plant can maintain working pressure with the damper closed to a position that will average 13 per cent CO_2, representing a preventable waste of 2 per cent, the firemen will properly be impressed, and by prolonging the test they will soon notice the effect upon the amount of labor they expend. If they fall into line they should be suitably commended.

Men who shovel coal as an occupation do not look upon fuel as a costly substance. They see it all day long day after day, ton after ton, until they have a subconscious idea that coal is the cheapest and most plentiful commodity in existence. There is need of disillusioning firemen on this point. The present cost of fuel requires the expenditure of time and money to save it.

A good gas analyzer may be depended upon to furnish accurate analysis of combustion conditions and serve to trace promptly the cause of preventable waste. Gas analyses, however, do not indicate boiler efficiency, which is affected by scale, soot and other factors. The CO_2 content of gases simply indicates the proportion of air and fuel in the products of combustion.

The accompanying chart illustrates one series of four gas analyses for each of three different boilers taken during a period of eight minutes between applications of coal, showing comparison between boilers equipped with automatically controlled damper, hand-controlled damper properly used, and boiler without damper. It will be noted the preventable waste of fuel due alone to improper combustion ranged from less than 1 per cent on the boiler with automatically-controlled damper to 14.5 per cent on the boiler without damper. Based upon a monthly consumption of 1,200 tons, this is equivalent to a loss of from 12 tons of coal per month on the one boiler to 174 tons on the other. These examples were taken at random from plants similar in size and are typical of results being obtained at many stations.



Effect on Flue Gas Analysis of Proper Use of Stack Damper

Curve No. 1 shows the percentage of CO_2 as analyzed from the gases taken from a boiler controlled by an automatically operated damper. It may be noted that one minute after fresh coal was applied to the fire, CO_2 was 15 per cent, and as this coal burned out, the percentage gradually reduced until at seven minutes the CO_2 was 13.3 per cent. The average CO_2 content for this curve is 14.3 per cent, or less than 1 per cent preventable waste of fuel.

Curve No. 2 indicates the trend of CO_2 readings for a like period on a boiler controlled by a damper in the stack operated properly by hand. The CO_2 dropped from 13 per cent to 7 per cent, making an average CO_2 content for this curve

10.5 per cent, which represents 5 per cent preventable waste of fuel.

Curve No. 3 indicates a series of CO_2 readings for a like period of a boiler without a damper of any kind, from which it may be noted that the first gas sample analyzed 8 per cent CO_2. This diminished to 5 per cent for the fourth sample at seven minutes, making an average of 6.6 per cent CO_2, or 14½ per cent preventable waste of fuel.

Effect of Properly Operated Stack Dampers on CO_2 Content of Flue Gas

	Curve No.	CO_2 content: per cent — Gas sample No. 1	Gas sample No. 2	Gas sample No. 3	Gas sample No. 4	Av'ge.	Preventable waste.	Fuel wasted from this source in a plant using 1,200 tons coal a month.
Automatic damper	1	15	15	14	13.2	14.2	1	12 tons
Hand operated damper	2	13	12	10	7	10.5	5	60 tons
Without damper..	3	8	7.5	6	5	6.6	14.5	174 tons

A big organization such as a railroad owns many stationary boiler plants. Because of separate supervision and for other reasons, such plants are seldom in like condition, and on account of the distance from one to another comparisons are difficult to make. There is, however, a friendly rivalry between employees of the various plants, and the writer has often been asked by the stationary engineer how the physical condition of his plant compared with other plants on the road. In order to satisfy this demand a report was made up showing the rank of the various plants being supervised, as determined by inspection. To arrive at a fair rank, a percentage allowance based on relative importance was made for each item, such as condition of boiler setting, presence of dampers, scale, soot, steam and air leaks, pipe insulation, interest of local forces in the plant, effort to follow instructions, etc. The total of all allowances was 100 per cent and rank was reached after deduction on all items not up to their allowance. The report bore the name of the location of each plant, with its rank. This report was sent to all concerned from general officers of the road down to the plant engineer. The report served its purpose. The fellows who found their plants down around 30 per cent and 40 per cent felt the sting of comparison with plants ranking 92 per cent, and they promptly began to make the improvements which it had otherwise been impossible to secure. One plant of 400 hp., on which considerable time had been expended in trying to arouse interest in its improvement without result, rose from the rank of 30 per cent to 82 per cent in 30 days after the first of these reports was issued. The results were so gratifying that it was issued at regular intervals until the plants were in the best physical condition possible under existing circumstances.

As a rule the boilers are the most uneconomical units in the power house. There are instances where plants are equipped with expensive turbo-generator sets, compressors and other engine-room equipment which are maintained year after year in first-class condition, while the boiler equipment in the next room is permitted to deteriorate. That this difference continues to exist is an absurdity, but it does exist in many cases. On railroads expensive facilities in the form of engine houses and repair shops are erected, manned and maintained, very properly, for the purpose of keeping locomotives in good, efficient, economical condition. In contrast with this practice the proper maintenance of stationary plants is neglected or ignored until after a few years' service, when it suddenly fails to perform its natural function. This contrast should be corrected, to the advantage of the boiler plant. It is cheaper to repair a plant when repairs are needed than to allow defects to accumulate.

Other features of maintenance and operation are fully worthy of consideration. Surfaces which waste heat by radiation should be insulated. The use of exhaust steam to heat feed water is so commonly practiced that it need only be mentioned. It is important, however, to keep feed water pumps moving continuously but as slowly as necessary, thereby maintaining the highest temperature possible with the steam available. Baffle walls should be kept tight to prevent the short-circuiting of the gases. Air, steam and water valves and connections should be kept free from leaks and the plant engineer should make regular inspection for these defects.

Scale and soot on boiler tubes offer great resistance to the transmission of heat to the water. Flues should be rattled or bored frequently enough to keep scale knocked off. Soot should be removed by dry steam or air at least once on each shift. A good mechanical soot blower is one of the most economical and satisfactory devices around a boiler plant. Every boiler should have one.

There are other features about a boiler plant which affect economical operation—too many to be covered by one paper. If all concerned in the operation of a plant are made to realize the good results it is possible to obtain and enthusiasm is created in working out the possibilities one by one, the defects will be overcome, with the result that the employees will be better satisfied with their work and economy will come into its own.

CANADIAN PACIFIC TO EXTEND ANGUS SHOPS

In order to speed up on the construction of equipment required on the Canadian Pacific large extensions are being made at the Angus shops in Montreal. These extensions will cover a quarter of a million square feet and are expected to cost approximately a million dollars. The largest addition will be made to the passenger car shops, amounting to 71,000 sq. ft., while over 58,000 sq. ft. will be added to the locomotive shops and 42,400 to the freight car shops. The following are the detailed particulars of the extensions:

Locomotive Shop.—The extensions to the locomotive shop will consist of an addition at each end of the present shop to give an additional floor area of 58,000 sq. ft. The construction will be steel frame with concrete foundation and brick walls. Mastic floor will be placed on the west end extension and wood block floor on concrete in the east end extension. The east shop extension is to be used as a running shed, and for this reason pits with mill type smoke jacks will be installed. All of the skylights will be constructed of wood and mill type ventilators will be used throughout this shop.

Freight Car Shop.—The addition consists of an extension to the present building at the west end, 106 ft. wide by 400 ft. long, giving an additional floor area of 42,400 sq. ft. The construction will be steel frame with concrete foundation, brick wall, wood floor and roof similar to the present building.

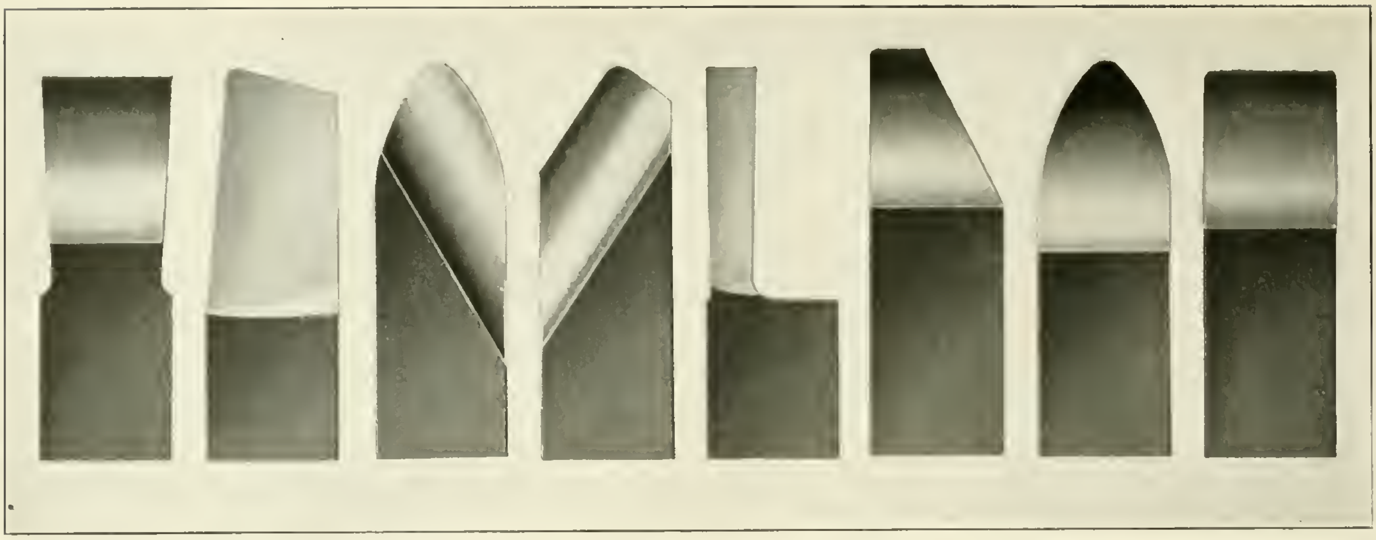
Pattern Storage.—This shop will be extended at the west end 75 ft., and will be 50 ft. in width, and a three-floor fireproof building. The construction will be steel frame with concrete foundation, brick walls, steel sash, concrete roof and floors.

Passenger Car Shops.—The new work consists of an extension 102 ft. by 161 ft. between Shops 2 and 4, and 137 ft. by 161 ft. between Shops 1 and 3; and a 137 by 239 ft. east end extension of Shop 3, giving a total increased area of 71,000 sq. ft. The construction will be concrete foundation with brick walls, mill type roof, concrete and mastic floors.

These shops will be all served from the present transfer table, the pit of which is being extended.

Car Electrical Shop.—This is a new building 62 ft. wide by 362 ft. long, giving a floor area of 23,000 sq. ft. The construction will be steel frame with concrete foundations, brick walls and acid proof mastic floor.

There will also be built a new planing mill shelter, an addition to the dry kilns, a high capacity track scale and a 50-ton coaling plant.



Tools Ground Direct from Bar Stock

PRODUCTION OF LATHE AND PLANER TOOLS

Grinding from Bar Stock an Economical Method of Manufacture; Centralized Tool Service Advantageous

BY E. G. BLAKE
Sales Engineer, Alfred Herbert Ltd., New York City

A REVIEW of the progress made by grinding as an economical method of removing metal shows a somewhat surprising number of engineering firms still making lathe, planer, shaper tools, etc., by the old fashioned method of hand forging. It is with the thought in mind of pointing out that grinding may be substituted for this method that the following is written.

Comparative Costs

The writer has no data available on the cost of forging tools, but the practice is so well known that it will only be necessary to give an idea as to the cost of grinding to leave no doubt as to the comparative cost of the two methods. Means are available today whereby a tool of any desired shape may be ground from stock of 1-in. by $\frac{3}{4}$-in. section in two or three minutes according to the shape, and other sizes in a proportionate time. It probably would take a blacksmith more than two minutes to heat the steel before he and his helper commenced a similar job. Hand forging is at best a rough and inaccurate method of producing any desired shape and carries with it the danger of maltreatment due to the hammering of the steel above and below certain heat limits. It is a well known fact that a large amount of high speed steel is ruined through bad heat treatment in the forging operation, and any method which tends to eliminate this waste should be considered. The grinding of tools from bar stock should, of course, be performed dry and the tool hardened afterwards. It will readily be understood that a tool ground on a machine especially adapted for this purpose to a predetermined shape requires very little regrinding after the hardening operation, whereas a forged tool needs to be corrected on a tool grinder or by hand to gages, and the cost of this is more in itself than that of the rough grinding operation on a machine specially adapted for the purpose. Add to these two costs that of hardening and we have a cost about one-sixth of that of forging and subsequent grinding.

Effect of Grinding on the Steel

Bearing on the question of forged tools a paper was presented as recently as December 19, 1919, by G. W. Burley of the University of Sheffield in London before the Institution of Mechanical Engineers. Mr. Burley headed his paper "Cutting Power of Lathe Turning Tools," and stated that the shape of the nose of the tool which was adopted as the standard in the original investigations is such that it can be obtained from a plain bar by the single process of grinding, but that in the case of the majority of shapes it is necessary to have the nose shaped initially by forging and finished by grinding. It appeared desirable, therefore, to determine whether this initial forging operation had any influence, deleterious or otherwise, on the quality of lathe turning tools. After giving details of the test bars forming the subject of this test, Mr. Burley stated that the results of the trials demonstrated that there was no appreciable difference between the cutting power of a forged turning tool and that of a similar unforged one provided that both tools are made of the same kind of steel and passed through the same hardening process. An excerpt from the paper follows:

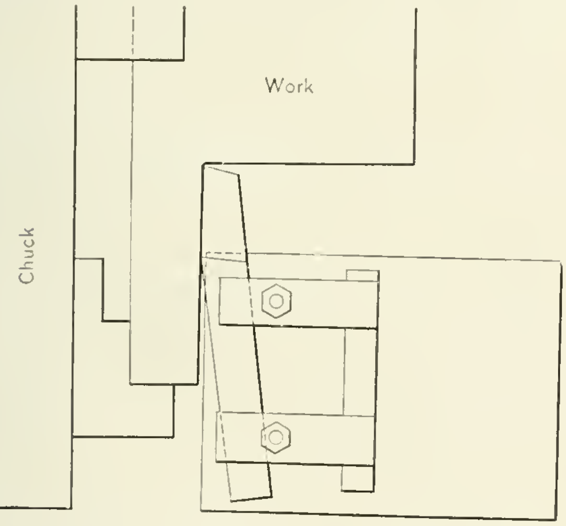
"This conclusion has been confirmed by results obtained incidentally from an extensive investigation which was made on tool steels as a special war research in the University of Sheffield. In this investigation nearly 1,000 individual tests were made on 332 tools of similar shapes under identical conditions, one-half of this number having forged noses and the other half unforged ones. An analysis of the results of the investigations shows that the two kinds were fairly evenly divided, practically one-half of the tools of each kind giving results above the mean, and the other half below with an average superiority of not quite 0.25 per cent in favor of the forged tools."

It would appear that the difference between forged tools and tools ground from bar stock, is negligible, and this information coming as it does from an authentic source should be particularly appreciated in view of the shortage of skilled

toolsmiths existing at the present time. This apart from the fact that experiments have shown that tools can be produced from bar stock by grinding much more economically than by the old time method of hand forging and grinding.

How Grinding from Bar Stock Affects Tool Design

Previous discussions on the subject of tool design have taken for granted that grinding is a long and laborious operation, and therefore the greater part of the remarks have been devoted to tool forging to be done in such a manner that subsequent grinding should take as short a time as possible. Due to the progress made by grinding, some thought should be put into the question of tool design, with a view to taking advantage of the many economies which can be effected by the grinding of tools from bar stock. Bent and offset forged tools are very often used without any thought as to why they should be bent or forged, although it is generally known that a bent tool is not so efficient as a straight tool, as the pressure on the bent tool is inclined to tilt the tool sideways owing to the width of the tool shank acting as the clamping base, whereas the straight tool takes the weight of the cut somewhere near the center of the section, which gives a support from the full length of the tool shank.



Tool Ground from Straight Bar Stock Applied to a Lathe.

The illustration shows the application of a tool which has been designed to substitute for the offset tool which is costly to forge, weak when made, and is soon rendered useless by regrinding, while the straight tool is stronger and has considerably longer life, as it will stand much more regrinding. This is a typical instance of what can be done with a little thought, bearing in mind the economies attached to the principle of grinding from bar stock. Almost any job can be handled in the same manner.

Toolholders—Butt Welding

Substantiating the statements as to the costly method of tool forging is the growing tendency to use tool-holders and tools with welded or brazed tips. It would appear at first that the use of tool bits and toolholders is economical, but our observations have shown us that this is not the case. Certainly the question of initial expense is in favor of the toolholder proposition, but when it is considered that only approximately 60 to 70 per cent of the steel purchased in the form of tool bits is actually used, it puts a different aspect on the case. All points considered, this latter feature seems to us very convincing, for, while the initial expense in purchasing tool bits is small, when the total purchase of high speed steel is taken into consideration and deducting from 30 to 40 per cent as absolute waste, it would appear that any other method which would reduce this waste should be considered.

The same argument applies to tools with brazed or welded bits. The life of these is very much limited because of the tip wearing in thickness due to regrinding. It is not logical to expect a tipped tool to last until the regrinding reaches the bar stock; therefore it is safe to assume that the same waste occurs as in the case of toolholders. In addition it is quite an expensive process to make the tipped tools in the first place. Using solid stock as an alternative offers very little better results owing to the fact that considerable waste is experienced when the bar stock becomes too short for use. A solid tool has, of course, the great advantage of being the best type for absorbing the heat generated by the cut, and consequently stands up longer. Our observations show that butt welding high speed steel to a carbon steel shank is the only way in which the full advantages of the solid tool can be obtained without the waste entailed by the use of toolholders and tipped tools. By welding a piece of high speed steel, one-third of the desired length, to a piece of low carbon steel of the same section, a tool is obtained which has the very desirable features of the solid tool and can be used by regrinding or reforging right back to the weld. Further, by using the high speed steel piece one-third of the desired length, the high speed steel portion of the tool itself has the necessary support afforded by the tool rest without the strain affecting the joint. This method is worthy of the consideration of anyone interested in the economical production of high speed steel tools.

Centralized Tool Service

Centralized tool service has often been considered, but very little progress has been made in this direction. No one seems to doubt the advantages that such a service offers, but one of the reasons why this method of making cutting tools in a shop is not adopted is because of the undesirability of having a blacksmith's forge connected with the tool-room. If the forging method was superseded by grinding, the necessary machines could be installed in the tool-room and would not interfere in any way with the organization in that department. In many engineering works the design of cutting tools is in the hands of the machine operators themselves, which results in a larger number of standards than is necessary and a consequent larger number of tools lying idle. Great economies can be effected by altering this state of affairs. In the first place the number of standards could be reduced to a minimum and a constant supply of tools always be available in exchange for dull or broken ones. This would also mean that the operators would spend less time at the grinding machine while their own machines were lying idle. Tools being ground to certain standards, assuming that these standards have been found to be the most efficient for the purpose, would consume less power in operation and would stand up to the work longer.

Herbert Spencer.—It may prove interesting, if not something of an inspiration to railroad men to know that Herbert Spencer, the greatest philosopher of modern times, began his career as a civil engineer on the London & Birmingham Railway. He was employed on this railroad and the London & Gloucester Railroad from 1837 to 1846, and according to his biographers was a very good engineer. In 1848 he became a sub-editor on The Economist and in 1850 published Social Statics, his first notable book on philosophy. The one hundredth anniversary of Herbert Spencer's birth was celebrated April 27. He was born at Derby, England, of Methodist and Quaker parentage. His father, who was a schoolmaster, did not have the means to send him to college, but his uncle offered to send him through Cambridge. He declined this offer, however, and chose to begin his career in railroad service.

How the Master Mechanic Increased Production*

Better Mutual Understanding and an Appeal to the Sporting Instinct of the Men Brought Results

BY E. F. JONES

JACK BRADLEY, Master Mechanic of the Big Shops, sat deep in thought. From all sources came the insistent cry for increased production, but there was no response. Everywhere he saw signs of restlessness. He, too, felt the daily surge of new and powerful emotions. The terrible strain of war with its great griefs, had, with the signing of the armistice, left the human family in a high fever of nervous reaction. He knew that it must run its natural course, but that ways must be found to keep it within due bounds. Humanity was on the march. Old ideas and customs had been torn loose and cast aside. Men who faced death in the trenches had come home with a new conception of life and were not content to pick up the threads of civil life where they had left them at the call of duty.

Walking through the shops that morning, Jack had looked at the men more keenly than usual. What were the thoughts and the feelings of these men who made up the working force of the big shops? Their state of mind showed in the apathetic manner in which they performed the various jobs. The atmosphere was comparable to a damp day. Coming back to the office he took particular notice of a swarthy Italian laborer doing a heavy lifting job. Although strong and robust the man worked in a listless manner. Walking up to him Jack said "Good morning, Tony," and asked a few questions about sunny Italy. Instantly Tony straightened up and saluted. With intense and passionate feeling he told of the land of his birth, of the suffering brought to his people by the war. His dark eyes shone eagerly and brightly as he told of his active war service and his voice grew a little husky as he visioned again the loss of his boyhood friends.

After Seeing That Everyone Was Comfortably Seated, Jack Started Slowly and Carefully to Explain the Object of the Meeting.

Several minutes later Jack looked out of his window and saw Tony working with new spirit and energy. He had gently and delicately touched the human chord in Tony's nature, and released a pent up flood of feeling. A little tangible personal interest had made Tony a happier man. He knew that the same chord struck with a rough hand would have produced a rasping discord. Why did the human family realize that years of study and training were required to bring out the tones of harmony in musical instruments, and neglect entirely the training that would bring harmonious response from the most wonderful instrument of all—the human body and soul?

Thinking deeply of this little incident Jack glanced at his desk covered with letters and reports. He knew without looking through the mass that not one letter or report dealt with the human factor of the big shops in a broad constructive way. Thinking back through the years past he realized that all the improvements for the men's comfort and health had been carried out according to a state or federal law, and none through the company's desire to make the workmen healthier, happier and better men. He realized deeply how production had suffered by this short-sighted policy, and determined, so far as was in his power, that not another day would pass under such a policy.

Calling in his chief clerk, Jack asked for a meeting of all foremen at one o'clock. As the word passed around it caused some wonderment, as a meeting had been held several days previously, and it was a very unusual thing to hold another so shortly. Promptly at one the foremen trooped into the big office of the master mechanic. They did not perceive the keen look bestowed upon them by "the old man," but it was the same look he had used in his walk through the shop that morning.

Jack felt a new sense of appreciation and confidence as he closely studied the faces of these foremen who had gone through many hard days and trials with him. As his eyes rested on the general foreman he felt a chill of apprehension. Here was a man of the old school who had won his position by his ability to drive and lash men in their work. He was of the bulldog type in build, manners and speech. In the presence of the master mechanic he was servile; in the presence of the men, domineering.

After seeing that everyone was comfortably seated, Jack started slowly and carefully to explain the object of the meeting. He told of his own feelings through the war period and the unrest he had felt in the days following. He told of the surging unrest of the whole world, and the need of meeting this condition face to face and in man fashion.

"We have got to play the game under new rules," said Jack, "and here they are. Our policy as supervisors has been to drive and dictate. We have reaped a crop of distrust and resentment. We are all together at this shop, yet it reminds me of a house with two rooms and both in darkness. The men in one room and we in the other are each planning new ways to get the better of each other. Neither can see what is going on as the darkness of secrecy and distrust is too intense. It is our duty to clear our room of this darkness and invite the men into a clear atmosphere of understanding and trust. This move will breed suspicion at first and we must prepare for rebuffs and disappointments. The clear light of our room however will soon work its cheerful power over the men, and they will gradually step in and look around furtively for the nigger in the wood pile. Frank discussions and above-board dealings will be the order of business in that newly lighted room, and soon those men will realize that we are doing our best to play square and

*Entered in the Railway Mechanical Engineer's prize story contest.

will go back to their dark room and tell their story of the new rules. The atmosphere of their room will gradually change to light and cheer. We then have a well-lighted cheerful house with free and friendly interchange of thought. This is the theory and our duty is to work it out in a practical business manner.

"Our first step is to interest the men in the work of these shops as a whole. They know nothing of our month's program, and never hear of their good work. We take the credit for that. When things go wrong, they hear of it through a 'bawling out,' which is frequently accompanied by curses. Every curse robs the treasury of this company by adding bitterness to the man's soul. A man in this mental state has a vicious desire to strike back and usually does. This striking back takes the form of destroying material, loafing, and other ways which only a bitter-minded employee can think of. The commonest expression of these employees is 'To Hell with it!' Curses and lack of humane interest on our part were the seeds which brought forth this terrible crop of destructive spirit.

"We have got to realize, men, that we reap what we sow and the man who sows must be responsible for his crops. Our new seeds are to be manly language and humane interest, and the crops will be good will and concentrated effort to please. We have hammered the men for years to increase production and the net results of constant hammering are a decreased production. This proves our failure and only stubborness and willful blindness will keep us on the rutty road of failure, when there is a broad, smooth highway nearby, leading to success.

"Results count, not misdirected efforts. Over there hangs the engine program board. I see it every day and so do most of you, but the men seldom see it, and know little of its use. Tomorrow the board goes into the shop and its purpose will be explained to every man. We will show how it keeps us informed of our monthly allotment of work and keeps us posted on our progress. We will keep this progress record in a way that all can read and understand quickly and easily. A graph board of 31 days will be placed next to the engine board. A bold straight line running from the lower left corner representing the first day of the month, to the upper right hand corner, representing the last day, will be the guide to show our anticipated daily progress. What is actually accomplished will show by a different colored line. This line will constantly remind the men if the shop is falling below the line of real effort, or is going above the line and keeping above.

"The natural instinct of man will make him fight to get above the line and a natural pride will be felt as he sees his efforts pictured in a way that means some real accomplishment. We have 172 engines assigned to this shop and to most of us they represent merely big pulling machines. They are a great deal more than that. They represent the mental and physical labor of hundreds of men and the finished locomotive remains the living part of what those men gave. It accomplishes its daily task successfully or otherwise, according to the quality of labor that made it a productive factor. Every day a large bulletin board will contain the performance record of each engine. Each man will be eager to see his workmanship stand the test. If a failure occurs the exact cause will be briefly explained and if due to faulty workmanship, the failed part, or a rough sketch of it, will be put on view for one day, under the number of the engine.

"No criticism will be needed, as the defective part will tell its own story of neglect or carelessness more effectively than words. This mute object lesson is not given to shame the employee for his neglect; its object is to educate and to teach its lesson in a way that reaches deep into the man, and awakens his sense of responsibility, showing him what a vital part he is of the entire organization. A new and powerful interest will be awakened in that man and its lesson will react on the other men as they will picture importance of their work and realize that they must not be the weak link in the chain.

"After these new policies have awakened the interest of the men, we will ask them to re-name their grievance committee, as that name suggests improper relations and discord. I will suggest the committee be named conference committee and its object will be to promote harmony, good will and confidence and to talk over all shop conditions in a big constructive way. We must educate our men to the point of view where they will begin to suggest economical ways of operating. If they say a certain part of the work can be expedited by making certain changes, and we cannot

"Red, What Do You Think of Our New Policies?"

agree, we will give them an opportunity to prove their point. This action on our part will make them very eager to show they are right and it will place a burden of responsibility on them which will broaden their vision and have a good effect on their future suggestions. Giving a workman the viewpoint of personal responsibility and creative opportunity to work out his own ideas on a job will improve his mental health and strengthen his loyalty. He keenly relishes the idea that he is a recognized factor in our shops and will respond vigorously. A man with this spirit will swing his hammer with twice the force, and oftener. Mental health is just as important as physical health in all our efforts. When you get this fact honestly worked out, the problem of increased production is solved, and it is the only solution."

Jack paused, and then slowly said, "Men, are you with me?" He had read his answer during the pause. Their faces already reflected the new spirit and their spontaneous assurances gave Jack high hope.

The general foreman sat red-faced and bewildered looking, and as the men left his office, Jack asked him to remain and said, "Jim, you don't agree with me on this, do you?", and Jim blurted out, 'Hell Jack, I'm no Sunday school teacher." Jack replied, "No, Jim, this is a man's job. Times have changed. It's the way of the world. Nothing stands still. We must go forward in step with the new conditions or drop out of line. It's going to be hard on you, Jim, but I want you to give the new rules your best efforts."

The general foreman left the office without comment. As the days and weeks went by, Jack felt the gradual improvement in the shop's pulse, and knew that the new medicine was taking hold. This improvement was slow and there were relapses. Jim, the general foreman, could not play the new game, and sent in his resignation.

One day a department foreman came to Jack and stated that he would have to fire one of his best men who was agitating continually and telling the men that a crooked game was being played by the management. This man was a natural rebel and leader, and Jack knew he had great influence over the other men, so he determined to convince him that the game was straight. Calling him in later in the day, he said, "Red, what do you think of our new policies?" Red was a little confused but shot back, that the management was "pulling the wool" again.

Starting in earnestly and slowly, Jack detailed the changes that had come over the world, and how imperative it was for everyone to play square. He surprised Red by admitting that the higher officers had made many mistakes in dealing with the men, and said most of these mistakes were due to their lack of contact with the men. Men who were out of actual contact did not understand each other's problems. "We are going to get closer together in this new game and we want you to play fair just the same as you would in a game of baseball. The only difference between baseball and business is that business is played by everyone and the most interesting game in the world if played on the level. What would you do to the fellow in a baseball game who continually tried to cut his corners or spike the basemen, and hollered murder when he was caught?" Red instantly answered, "I'd break his damn neck." "Well," continued Jack, "that's what is going to happen to all the crooked players in this game of business. Clean business will not tolerate crooked players, and they will be put out of the big game, and some of them crippled so they can never play again."

Red's interest was awakened and his manner changed.

A Shrill Boyish Voice Called "Hey Jack, How's Your Golf"

The earnest, sincere way in which Jack pictured the game, appealed to Red and he eagerly began to suggest ways and means of improving the shop work. For a full hour they went over various phases of the work, and Jack learned more in that hour than he had in a month's inspection. The ingenious Red became one of the strongest players, and supported the new ideas with all the strength of his virile personality. The shop pulse now began to show decided improvement. The men walked with a snappier step, they swung their hammers with new spirit, and the general atmosphere of the shops was surcharged with vigorous vitality and cheerfulness. Engines began to leave the shops ahead of their schedule time, and the graph chart showed the month's work finished three days ahead of time. The conference committee recommended an increased allotment for the next month, and the end of that month showed the graph with a perfect record. Not once did the men allow their progress line to go under that forbidding line. Their fighting pride would not allow it.

The next feature to be introduced to the shop, was a shop news board, where the most interesting items of the daily shop mail were posted each morning. Hitherto the men had to depend on the "stove pipe" committee for their shop news. Now they were given this news in a brief authentic way and the eagerness with which they read these items was ample proof that they had been starving for mental shop food. The daily serving of this mental food satisfied this hunger and developed an interest in the work of the entire shop that was marvelous.

The increased production of the big shop was of course noticed by the general superintendent of motive power and he wrote Jack a letter of congratulation. Jack was too big a man to accept the entire credit and wrote to the general superintendent asking that he include the entire forces of the shop in his congratulations. This spirit pleased the general superintendent, and his next letter was stronger than the first, and included the entire personnel. Jack personally placed that letter on the shop news board, and felt that it represented the beginning of a better understanding between the management and the men.

Several days later the general superintendent visited the big shops and noticed the general air of good feeling which abounded. As they walked through one of the engine houses, a shrill boyish voice called "Hey Jack, how's your golf?" Turning quickly, Jack noticed a grinning grimy face peering over the top of one of the pits. The voice had a familiar sound, but the grime was so thick that he failed to recognize the face, so he walked over to the pit and peered down into the smiling eyes of a youngster who had been his caddy at the golf club. Jack's hobby was golf, and a warm friendship had developed between him and the boy. The cordial friendly greeting of the boy warmed Jack's heart and brought a big smile to the serious face of the general superintendent. Asking the boy a few friendly questions, they passed on.

Returning to the office of the general superintendent asked Jack to tell him the entire story of the new spirit in the shops and Jack gladly complied. The general superintendent was deeply interested and asked Jack's aid in developing the new spirit at all the shops. This Jack readily agreed to.

Months of patient work brought the same good results at the other shops, for the men were of the same mould and needed the same humane treatment and mental medicine to restore their interest and vigor. The new spirit spread throughout the railroad and Jack felt great satisfaction when the general manager recognized it as the main factor in the greatly increased efficiency.

The men had found that true happiness could be found in their work if they played square and they could trust the management to play square with them.

Present Cost of Rolling Stock in France.—A French paper called the "Journee Industrielle" has recently made a study of the present cost prices of rolling stock in France. The results of this investigation show that it costs from \$4,050 to \$5,400 for a box car, \$3,375 to \$4,725 for a gondola car, and \$2,025 to \$2,700 for a flat car. The cost price of a modern passenger car, equipped with the latest improvements, is about \$67,500 for a first-class, \$43,875 for a second-class and \$33,750 for a third-class carriage. The prices noted are given at present rates of exchange.

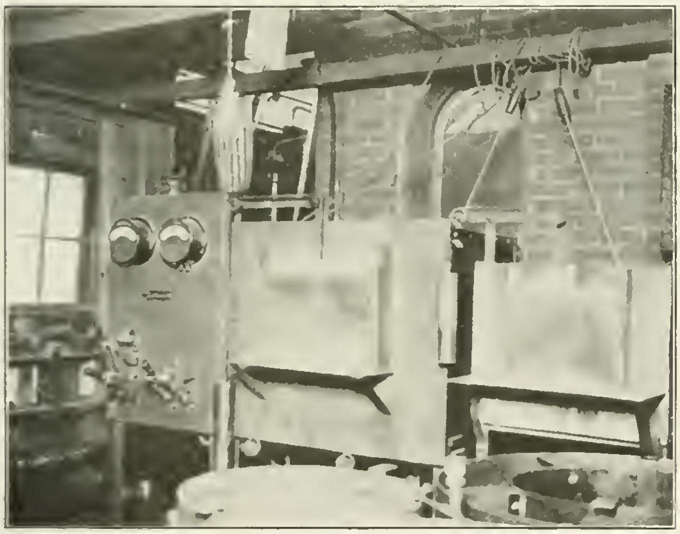
A Modern Tool Room Heat Treating Plant

Electric Furnaces and Pyrometers Installed at Ft. Wayne Shops of the Pennsylvania System

ACCURATE temperature control in heat treatment is one of the most important considerations in insuring good tool service. This is a fact which is coming to be generally recognized in railroad shops, and the use of special equipment has for several years been replacing the old hand forge method of hardening and drawing these tools.

A new heat treating plant has recently been installed in the tool room at the Ft. Wayne, Ind., shop of the Pennsylvania System in which complete provision has been made to insure uniformity of results with the expenditure of a minimum amount of labor. The plant is adequately equipped for handling all classes of tool work and is of particular interest from the fact that electric furnaces and pyrometers are used for the hardening operations.

The plant is called on to handle a wide variety of work, some of it in considerable quantities. The largest output is beading tools and flue expanders. About 300 beading tools are treated a week, for use at Ft. Wayne and a number of other points on the system. The output of flue expanders is considerably less, but in putting them through the plant they are handled in lots of about 200 at a time. The remainder of the output is made up of special tools of various kinds, such as taps, reamers, special milling cutters, inserted cutter blades, shear blades and punch and die work. Several examples of the variety of special tools turned out are shown in one of the photographs. In the manufacture of many of these tools, axle steel, case hardened, has been used.



Electric Furnaces and Switchboard at the Ft. Wayne Heat Treating Plant

The Electric Furnaces and Equipment

All hardening and annealing operations are carried out in two electric furnaces. These furnaces are of different types and provide different temperature ranges. The two are used together on hardening operations. The low temperature furnace, shown at the right in the illustration, has a maximum temperature limit of about 2,000 deg. F. and is used for annealing and hardening carbon steel tools, heating case-hardened carbon steel tools for quenching and pre-heating tool steel to a temperature of about 1,800 deg. F. The high temperature furnace has a maximum temperature limit of 2,500 deg. F. In this furnace the pre-heated tool steel pieces are finished to the proper hardening temperature, ranging from 2,250 deg. to 2,300 deg. F.

Both furnaces are of the muffle type but differ materially in the type of heating elements used. The elements in the smaller furnace are of the so-called hairpin type. Surrounding the refractory muffle are four slabs of refractory material provided with longitudinal slots in which fit the hairpin heating elements. These elements are inserted by removing the furnace front, which exposes their closed ends, and are placed entirely around the top, sides and bottom of the muffle lining. At the rear of the furnace, the ends of adjacent elements are joined by a series of connector blocks, with the exception of one pair to which the lead terminals are attached. This furnace operates on a maximum of 55 volts which is obtained by means of a regulating transformer. The secondary winding is divided into sections, each of which corresponds to a different voltage and the terminals of these sections are connected to a bank of single knife switches by means of which any section, or combination of sections, may be connected to the heating elements of the furnace. There are five of these sections, which afford a wide range of voltage and temperature regulation.

This furnace has a heating chamber 26 in. long by 8 in. high by 12 in. wide and has a full load rating of about 15 kilowatts. At full load about one hour and thirty minutes is required to bring the furnace up to its maximum temperature limit of 2,000 deg., after which this temperature may be maintained on about two-thirds of the full load rating.

The high temperature furnace has a heating chamber 18 in. long, 8 in. high and 12 in. wide. In this furnace the heating elements are carbon plate resistance piles which are placed inside the muffle on both sides. These plates are about ¼-in. thick and rest on heavy graphite blocks at the bottom. At the top the two piles are connected by a set of heavy transverse carbon plates. Graphite electrodes extend vertically through the bottom of the furnace and bear against the bottom of the graphite blocks, one on either side of the furnace. Hand wheels located conveniently in front of the furnace, through beveled gears, operate elevating screws which in turn bear against the lower terminals of the electrodes. The current thus passes from one electrode up through the carbon resistance pile on one side of the furnace, across the top to the carbon slabs, down through the carbon resistance pile on the other side of the furnace and out through the other electrode. Temperature control is obtained by varying the upward pressure against the carbon piles and hence varying the resistance.

Like the lower temperature furnace, current is obtained from the secondary of an air-cooler transformer which is wound in one section. The maximum voltage for this furnace is kept down to about 30.

This furnace has a full load rating of 30 kilowatts, at which about one hour and thirty minutes is required to bring it up to its maximum working temperature. Considerably less power is required to maintain a uniform working temperature after the furnace has become thoroughly heated.

The switchboard, shown at the left in the illustration of the furnaces, contains a switch, circuit breaker and an ammeter in the primary circuit of the high temperature furnace transformer. The pyrometer is connected to a double-throw switch by means of which it may be connected to the thermo-

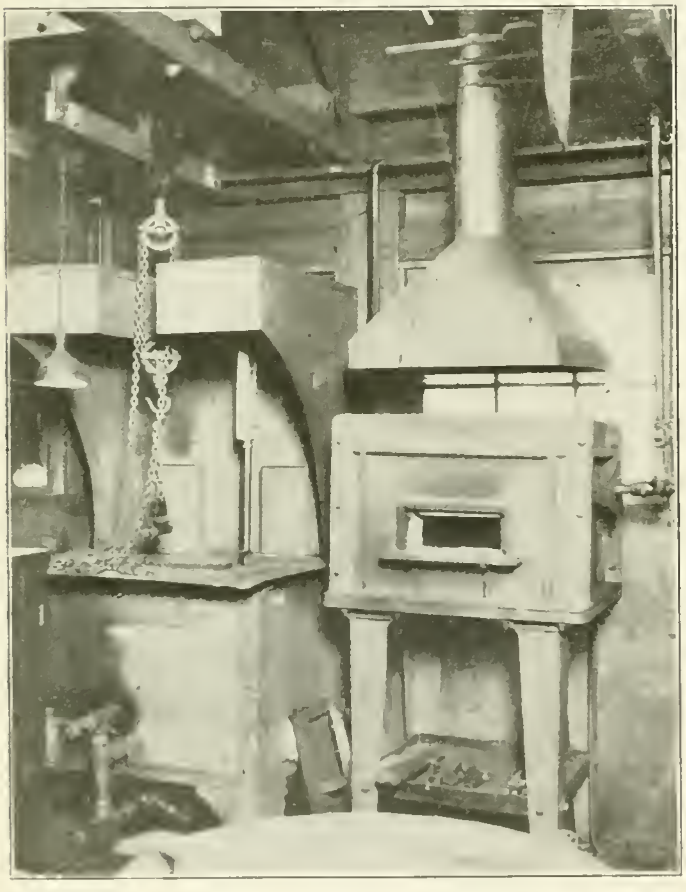
couple in either of the two furnaces. The switchboard for the low temperature furnace is attached to the side of the furnace frame.

Other Equipment

For low temperature drawing work an oil burning furnace of the oil bath type has been installed. Above this furnace has been placed a short monorail from which is suspended a chain hoist for handling the basket container into and out of the oil bath. As will be seen in the illustration, the temperature of the oil bath is indicated on a thermometer which forms part of the equipment.

A small oil burning muffle furnace has been installed to take care of various odd jobs for which the other equipment is not adapted. This furnace is useful for small forging jobs which it is desired to perform in the tool room and it is also used for short heats in hardening lathe centers and other pieces which it is not desired to heat all over.

The equipment of the plant also includes three quenching tanks containing water, salt water and oil, respectively. The



The Oil Bath Tempering Furnace and Small Oil Burning Muffle Furnace

oil and salt water tanks are jacketed and cooled with flowing water. These tanks are conveniently located to the electric furnaces. In hardening carbon steel tools they are first quenched in water till the vibration ceases and are then transferred to the oil. High speed steel tools are quenched in oil.

Classes of Work Handled

When a run of high speed steel tools is to be treated both electric furnaces are used. This reduces the time required for the complete heating operation to that required to preheat the tools to about 1,800 deg. in the low temperature furnace. Work of this kind is handled in lots in order that as long a run as possible may be obtained without the necessity of cooling down and reheating the furnaces.

When annealing is to be done, the parts to be annealed are placed in the furnace at the end of the day's work, brought to the required temperature and allowed to cool down in the furnace during the night. This work is thus a by-product of the regular operation of the plant and costs practically nothing for power or labor.

Reference has already been made to the variety of special tools which are handled in the heat treating plant and to the fact that some of these tools are made from axle steel and case-hardened. The use of this material offers a number of advantages where occasional jobs come into the shop requir-

A Number of Special Tools Representative of Work Turned Out of the Heat Treating Plant

ing special tool equipment and also for tools which are regularly but infrequently used. This material is not used for cutting tools which are expected to operate at high speed.

In the illustration showing a number of these special tools, the first one at the right is a hob which was made for use in replacing a broken worm gear from a coaling station on the line. This cutter was machined out of axle steel, sent to the blacksmith shop for case-hardening and reheated in the tool room for quenching. By its use the new gear was cut and the plant returned to service with only a few day's delay at an expense from which the cost of tool material was practically eliminated. Such tools manufactured from tool steel are difficult to harden without serious risk of fracture and loss both of the material and time expended in their manufacture. The case-hardening process is comparatively easy to handle and where the quenching heat is under control, as it is in the heat treating plant, perfect results are assured. Other tools of the same material shown in the photograph are a large 45 deg. reamer, a special reamer for finishing the piston rod pits of crossheads and a large special tap.

Among the other tools which have been developed and manufactured in the tool room are shown two sets of punches and dies for cutting piston rod and valve stem swab rings and a special three-fluted cutter for machining the crosshead key slots in piston rods. This work is done by first drilling a hole of the proper size at one end of the slot, setting the rod up on a milling machine table with the cutter inserted through the hole and finishing the slot with the cutter.

At the left in the illustration is shown a set of punches and dies for perforating driving box grease cellar plates. The punches are mounted in short sections of hardened steel which in turn are secured to a soft steel bar. The die blocks are also formed in short sections and similarly mounted on a bar of soft steel. The punch on which the work is done operates at the rate of 80 strokes per minute. Each stroke

perforates two rows of holes and the work is complete in 19 strokes at a total time of about a quarter of a minute per plate. The finished plate is clean and smooth with no distortion or fins at the edges of the holes whatever.

The equipment of the plant includes a Sclerscope, which instrument has proved of value in checking up the work of the plant and determining the temperatures to be used on various steels.

Results

The plant has justified expectations as to providing better and more uniform service from the tools turned out. Before this plant was installed, in making up a lot of flue expanders it was the regular practice to include a number of extra sections in each lot. These were always needed to replace sections broken in hardening. Since the electric furnaces have been in use, no breakages of this kind occur and the physical qualities of all of the hardened sections are exactly alike. When beading tools were hardened in the blacksmith shop they frequently broke in the shank, it being impossible to harden them all over alike. Now these tools are heated to a uniform quenching temperature all over and so far no trouble has been reported from failures in service. The same conditions apply with respect to special rivet sets and air hammer chisels. These tools are annealed, hardened and drawn at a uniform temperature all over.

Not the least of the benefits which have resulted from the operation of this plant is the saving in labor as compared with the old methods of heat treating tools in the blacksmith shop. To take care of this work it formerly required two men on blacksmith fires. Now, one man is easily able to take care of the work, which from the tool hardeners' standpoint is performed under conditions far less exacting. The operation and maintenance of the electric furnaces requires no knowledge of electricity, and skill in regulating furnace temperatures within narrow limits is readily acquired with a small amount of practice.

THE DRIFTING VALVE

BY S. H. LEWIS

When a locomotive drifts the fire box gases, at high temperature, smoke and the atmosphere are forced into the cylinders and destroy the oil which is supplied for lubricating them. These elements leave abrasive deposits and cause the cylinder packing to break or wear out in a small percentage of the time that it would otherwise be useful. This in turn decreases the power of the locomotive and in point of economy and service the exclusion of the gases, smoke and atmosphere is desirable and important.

To prevent the creation of vacuum within the cylinders, numerous valves have been invented for supplying steam to the cylinders while the locomotive is drifting, and the best known of these may be considered as being of three types, viz., hand-operated, semi-automatic and automatic.

Owing to human fallibility the hand-operated valves are unreliable and dangerous. As they are not opened regularly they do not prevent the creation of vacuum at all times when the locomotive is moving and damage results. As they are not closed with regularity they have caused locomotives to move or slip when unattended, and have increased the liability of personal injury and damage to property.

The semi-automatic valve employs a pressure operated valve in conjunction with a hand operated control valve which is supposed to be opened at the beginning of a trip and closed at the end of the trip. This type is open to the same criticism as the hand operated type with respect to human fallibility.

The automatic valve is either pressure operated or mechanically operated and will give the desired results only where such valves prevent the pressure within the cylinders from falling below atmospheric pressure *at all times* when the locomotive is moving.

From the foregoing it may be reasonably concluded that a drifting valve should be automatic, and as expense is increased and service impaired by the creation of vacuum in locomotive cylinders, it is obvious that a drifting valve should not depend for its operation upon vacuum created in the cylinders. It is equally true that a drifting valve should not depend for its operation upon compression created in the cylinders as compression and vacuum occur simultaneously in opposite ends of the cylinders.

Classification of Drifting Valves

The steam supply pipe should be arranged to prevent condensation and the delivery pipe from the drifting valve may be so arranged that *superheated* steam may be supplied to the cylinders through the valve chests and steam distribution valves or *saturated* steam may be supplied through the same channel, or *saturated* steam may be supplied direct to opposite ends of the cylinders. These methods are subsequently referred to respectively as arrangement *A*, arrangement *B*, and arrangement *C*.

In arrangement *A*, the steam is delivered to the *saturated* steam compartment of the superheater header or the dry pipe, and passes through the superheater units before reaching the steam chests and cylinders; in arrangement *B*, the steam is delivered to the *superheated* steam compartment of the header or piped direct to the steam pipes or steam chests, and in arrangement *C*, the steam is delivered to the cylinder clearance spaces through non-return check valves. The check valves serve to prevent the passage of steam from one end of the cylinder to the other when the throttle is open.

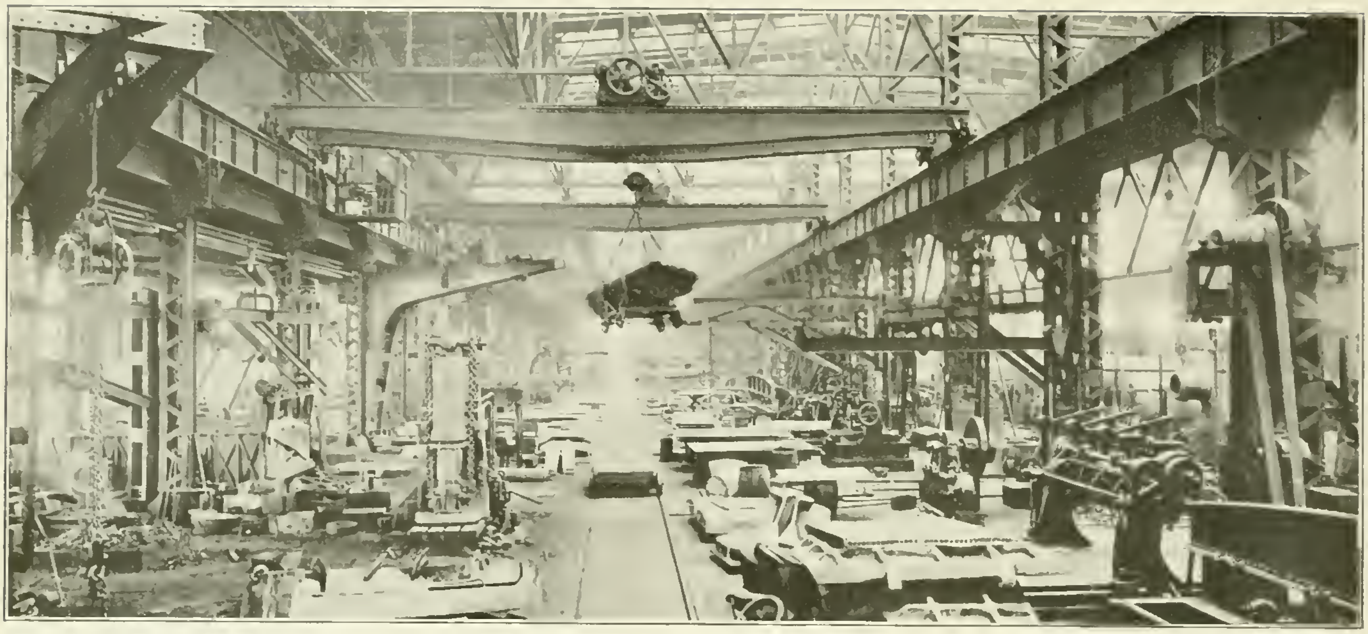
With arrangement *A*, the drifting valve may remain open at the time that the locomotive is moving as the steam from the drifting valve passes through the superheater units when the throttle is open and when the locomotive drifts.

With arrangements *B* and *C* it is necessary, in addition to the drifting valve closing automatically with the stopping of the locomotive, that it close automatically with the opening of the throttle when the locomotive is moving in order to prevent delivering saturated steam to the cylinders with the *superheated* steam when the throttle is open. It is also necessary for the prevention of vacuum, for the drifting valve in the arrangements *B* and *C* to open automatically with the closing of the throttle and in time to maintain steam within the cylinders until the locomotive stops or the throttle is again opened.

The volume of steam necessary to prevent the creation of vacuum in the cylinders varies according to the diameter of the cylinders, the speed of the locomotive and the position of the reverse lever or point of steam cut-off, and will require approximately the use of a 1¼-in. pipe for 22-in. and smaller engines, a 1½-in. pipe for 23-in to 26-in. engines, and a 2-in. pipe for 27-in. to 30-in. engines.

Advantages of Drifting Valves

It has long been recognized that manifold advantages, including the prevention of vacuum, are derived from the presence of steam in suitable quantity in the cylinders of a locomotive at all times when the locomotive is running above a very low speed, and that these advantages can be fully derived only through means to supply and cut off the steam automatically. A drifting valve which functions properly distributes and preserves the valve and cylinder oil, provides a steam cushion for the machinery, prolongs the life of the cylinders, pistons and rod and cylinder packings, protects the superheater units and prevents the loss of high cylinder temperature when drifting and results in increased locomotive mileage, decreased maintenance cost, higher average power, and increased mileage per unit of lubricant.



Looking Up the Machine Side of the Boiler Shop, Canadian Pacific Angus Shops, Montreal

Taking up the Slack in Production

How Causes of Lost Time on Unit Operations are Located and Removed at the C.P.R. Angus Shops

BY E. T. SPIDY
Production Engineer, Canadian Pacific, Montreal, Que.

The functions of production may be divided into two classes: first, those which devolve upon the management, and second, those for which the workman is responsible.

In the first class are the duties of the supervisory staff to handle all orders, get the proper material to the workmen, plan the work in order that the desired output is obtained, provide the workmen with proper tools, keep the machinery in order, see that each operation is performed at the right machine, provide suitable workmen for each machine, and so on. These functions are performed by the foremen alone in small shops, or by an increasing number of specialist supervisors, each attending to one function only, in large organizations.

The rate at which the actual work is done by the workman depends entirely on the skill and knowledge of the individual only when the functions of the supervising organization have all been performed properly.

The question is, how do we know whether all these functions are being performed properly? Do we know what output we are getting from each workman compared with what he should produce? What is the reason for the failure to get full output from each man? What action is taken when we do know the reason for these failures? No one will say that these are not vital questions, yet, how many railroad shops have any definite system by means of which they can determine the answers with any degree of accuracy?

These are days when material is hard to get. Conditions are different from any previously experienced and good men are exceedingly scarce. Wages are so high that our old conceptions of what a job should cost are worthless. It is obviously our duty, not only to the railroads but also to ourselves as citizens who realize that idleness expense—which is what inefficiency really means—can only add to the growing cost of living, to reduce this idleness expense by first finding out where it is and then applying the best available remedy. If we know where it is something can be done.

The methods of accurately determining the answers to the above questions which are described below are not new. They have been developed by a number of industrial engineers and applied in various ways to meet varying local conditions. In some shops the production department looks after them, in others the foreman himself has a man detailed for the work and supervises it personally. The process of checking up the details of production in a few departments will clearly develop the system.

It may be assumed that something appears to be wrong with milling machine production. A man who has the status of an assistant foreman is sent to that department with instructions to keep an accurate record of all the work being done by these machines. He records the time when each job starts and when it finishes. He is on the spot constantly and notes every time the workman is delayed. He is looking for the delays, and as soon as one occurs he notifies the shop foreman, the tool foreman if it is a tool failure, or whoever should apply a remedy. The record of these delays and the amount of time lost is retained for the purpose of compiling the summary records described later. As each job is started he ascertains the time it should take and notes this for comparison with the actual time taken. The time which should be required may be taken from piecework schedules which most shops have, even though not in use, or when no records are available, it may be estimated on the floor.

As soon as the time on a job has exceeded what we may call the allowed time for that job, lost output is obvious and the observer must account for the discrepancy, showing the reason on his record. He then notifies the foreman or supervisor responsible for correcting the faulty conditions as soon

as possible, and takes such action himself as is within his power.

Each day's performance is summarized on the special form shown in Fig. 1. Each sheet lasts for one week, and usually a record is kept continuously for two weeks in the one department, by which time usually the habitual delays of the department are fully apparent. In addition to those for which remedies may be applied immediately, there are often conditions requiring a change in policy which take some time to put into effect. These are discussed by the supervisors concerned, and the necessary consent having been obtained from the higher officers, are put into effect as soon as possible. Later on another department check is made to determine whether the improvements have had the desired effect and whether there are any further controllable delays.

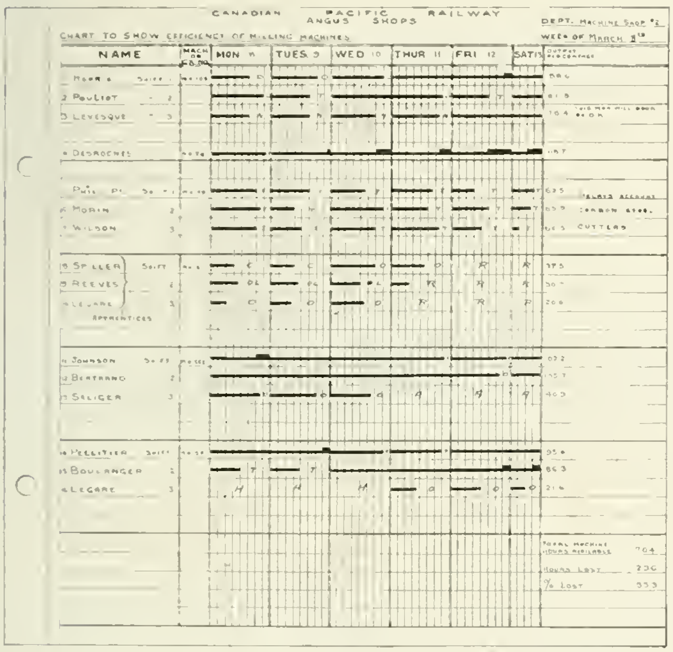


Fig. 1.—Chart Showing Results of a Detail Study of Milling Machine Operation

The heading of the form states its purpose. A column is provided for each day of the week, and each day is subdivided into hours to facilitate entries. Each day's record is distinct and not combined with the next day in any way. When work runs into the next day, as it often does, the entry is not made until the job is completed, and then the percentage efficiency is prorated for each day. Horizontally, 100 per cent output is represented by the distance between the day columns, which on the actual form is one inch. If the operator gives only six hours' output in eight hours a thick black line is drawn in the space for the day equal to 6/8 of its width. The remaining space represents lost output and in it is placed a symbol letter or sign indicating the reason for the loss.

For convenience and uniformity a standard set of symbols is used which covers all delays in a general way. These are supplemented when necessary in certain departments to show special conditions. They are as follows:

A—*Man Absent.*—Used when there is available work, and a workman assigned to the job who is absent for any reason. This calls for the foreman to investigate causes and to discipline the absentee when necessary.

H—*Lack of Help.*—Used when there is work at the machine and no men available. More men are usually required if this appears frequently.

N—*New Man.*—Used to denote that the delay is caused by a new workman who is not yet familiar with the work. Such a man is expected to make good in a short time. This may call for instruction by the foreman.

O—*Up to the Man.*—Used when there is reason to believe that all conditions are favorable and the workman could himself prevent the lost time. Consistent delays on this account indicate that the man should be replaced.

X—*Reason Not Clear.*—Used when it is believed that the man is not to blame and conditions are good.

D—*Defective Work.*—Sometimes a defective piece of work requires special care that makes a delay. This account is up to the shop foreman to regulate.

M—*Defective Material.* Used when the delay is creditable to defects in the material itself. Troubles from this source are referred to the test department or to the purchasing department.

W—*No Work.*—If no job is available when a man finishes the job in hand, the time lost in hunting up the foreman to get one is charged here. The extent of losses on this account are an indication of poor management in most cases, although it may be due to lack of orders, in which case the man must be disposed of on other work or laid off.

I—*Lack of Instructions.*—Used when delays occur due to lack of information or instructions of any kind, such as no drawings or sizes, which any supervisor has to supply.

P—*Power House.*—If compressed air, steam, water or any other power supply goes off it is recorded under this heading. This item is usually up to the power house engineer.

R—*Repairs.*—Used when the machine is placed under repairs, because of breakdown, changes or any other reason, when there is work available. The shop engineer is usually responsible for keeping this item down.

T—*Tool trouble.*—Failure to deliver output on account of defects, repairs to, or breakage of tools is up to the tool shop foreman to correct. Lack of a proper supply of tools and delays in getting them are also included in this account.

V—*Shop Closed.*—Used when vacations or any other shut downs occur, during which no output is expected.

Some delays cannot be overcome, but it is seldom that something cannot be done to prevent them from becoming of regular occurrence. Delays may often necessitate several supervisors getting together before a remedy is decided on, which always results in some future improvement being effected.

Referring to Fig. 1, it will be noted that the first man, Morris, turned out 60 per cent of a day's work on Monday, 70 per cent on Tuesday and better still each day; it was proved that there was no trouble for which he himself was not responsible. This is a common experience under this system. The second man, Poullet, was evidently an experienced operator, but had tool trouble on Tuesday. This proved to be accidental. The third man, Levesque, was a new man and unfamiliarity with the machine was responsible for his delays. These three men all operate the same machine on different shifts.

Deroches, the fourth man, is an efficient operator. Practically every day he turned out more than the allotted day's work, as indicated by the extra line. This, in a piecework shop, represents earnings over his wages.

The next three men each failed to give a day's work on account of tool trouble. This trouble was so apparent and consistent that it led to an investigation which showed the necessity of making a change in policy. It was found that owing to war exigencies this machine was equipped with carbon steel cutters. It was proved conclusively that high-speed cutters were required to reduce the expense of the work, and instructions were issued for this change to be made as soon as possible. Incidental to this, a change in design was found desirable. It was shown in experiments made later that by using a high-speed cutter of larger diameter and shorter length better time was made milling around links and such work singly instead of doing two at a time. Two pieces at a time produced too heavy a load for the machine.

Items 8, 9 and 10 show the performance of a machine run by apprentices. This was not very good, and on Thursday it will be seen that the machine broke down and one apprentice was transferred to the last machine on the sheet, where there was a vacancy on the third shift.

It will be obvious that a chart of this nature tells the whole story of shop output and troubles. The expense of getting it is negligible compared with the value of a knowledge of all the facts and the ability to place them before the right parties—the only way to ensure better results.

A summary of Fig. 1 shows that there were 704 machine hours available for production. Summarizing the delays, it will be seen that 236 machine hours have been lost for various reasons, a loss of 33.3 per cent for the week. These losses are chargeable as follows:

	Hours	Per Cent of available hours
R—Machinery repairs	49	7.0
T—Tool trouble	63	8.9
N—New Men	10	1.3
O—Lack of skill	61	8.6
A—Men Absent	20	2.8
H—Lack of help	24	3.4
X—Reason not clear	3	.4
L—Instructions	6	.9

By presenting the responsible supervisors concerned with data of this nature they all realize that a measure of their efficiency is in the hands of the management, on which fair judgments can be based.

The reason for the delays is always insisted on, and shifting responsibility is of no use because the other man will refuse to accept what is not his due. On the workman's part he realizes that a continued bad showing surely will result in his transfer to inferior work, or worse.

Fig. 2 shows another of these forms on which is recorded a specific condition. Having a large amount of boiler work on hand and not being satisfied with the output, it was determined to learn the reason for what was considered an excessive amount of time required for each engine.

The department, it will be noted, is operating two shifts,

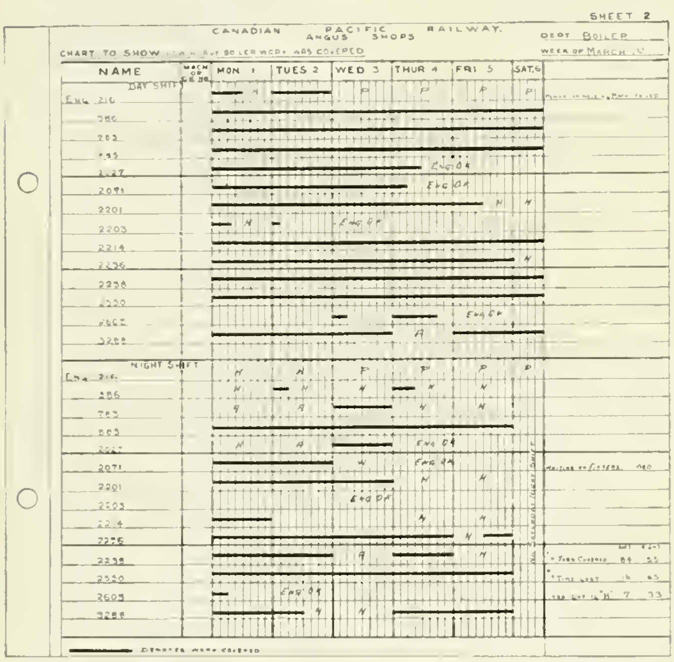


Fig. 2.—Chart Showing the Effect of Insufficient Help on Heavy Boiler Work

and the top half of the chart is devoted to the day gang, while the lower half covers the same engines on the night gang. On this chart is being checked how the work is covered by the workmen, to determine the reason why no workmen are on a job when the work is available. In this case spaces representing time with no boiler work scheduled are left blank.

This chart shows very plainly that the boiler shop foreman is confronted with more work than he has men to cover. It shows also that he has much trouble with absentees. The lack of uniformity of the lines on the chart shows that despite all planning to cover work, on account of the absentees and shortage of men he is switching his men from one place to another to make the best use of them.

A few other reasons for delays requiring investigation are to be seen on this chart. Delays marked H' prove that the fitters are not through when the boilermakers arrive to make the test, which indicates the weak point.

The chart shown in Fig. 3 looks altogether different from the others, showing few delays and in general all operators making good. This indicates what a good chart should look like, although it might be still better. There are features which should be looked into, such as to be sure that the shop is not overstaffed with non-producers, but it reflects good management by its obvious lack of lost time. This shop is a manufacturing department and is not subject to such quick changes and short-time jobs as the others. It should not, of course, be judged on exactly the same terms.

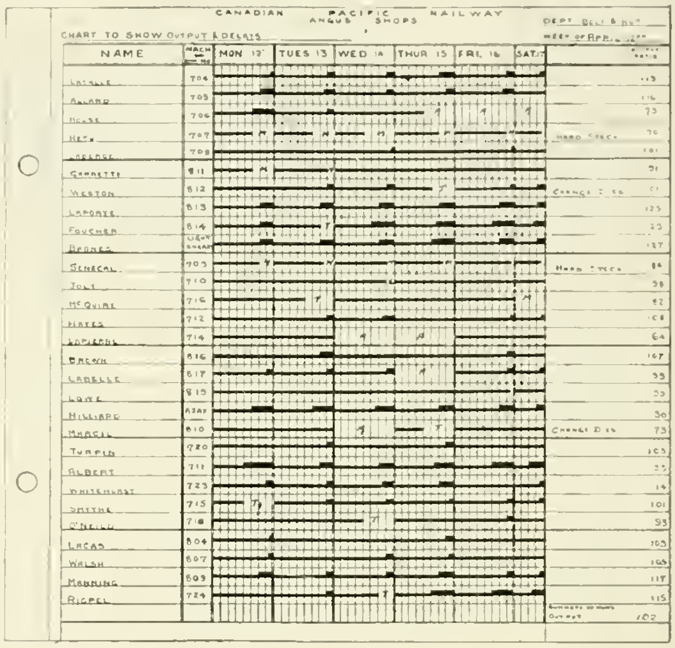


Fig. 3.—A Chart Taken in a Manufacturing Department

Fig. 4 shows a form on which the details are recorded by the checker. Each job is entered as it is started and is filled in as the work progresses. Delays are usually entered on the line below, with reasons in detail.

This system is independent of any other system in the shop, and it does not matter whether it is a daywork or piecework

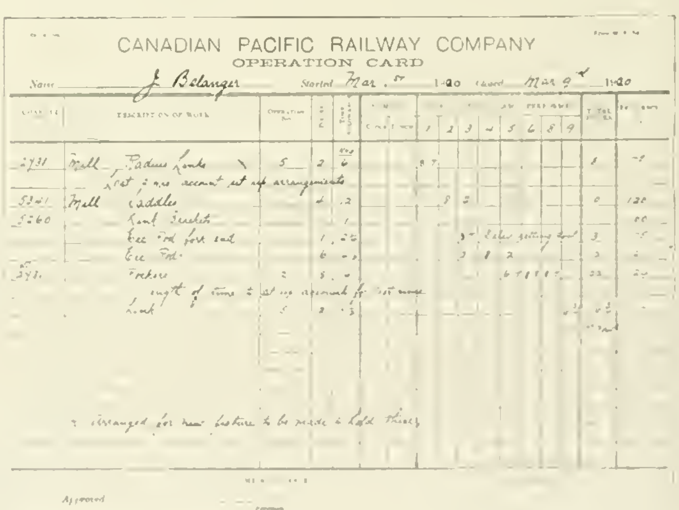


Fig. 4.—Form of Record Sheet Used in Making Detail Studies of Delays

shop. It has no connection with the shop schedule or routing system, although it shows up defects in them if work is delayed. It can be adapted to show special conditions, as pointed out in Fig. 2. By reducing lost time to a minimum a greater output may reasonably be expected, and such results have actually been obtained.

Air Consumption of Locomotive Auxiliaries*

Cost of Wasted Air Shown and Condemning Limits Proposed to Raise Standard of Maintenance

THE subject of pneumatically operated auxiliary devices† on locomotives was assigned to a committee after the meeting of the Association at Cleveland, May, 1918. The committee presented a report of progress at the last meeting and was continued for the following purposes:

(1) To obtain more complete and representative data concerning the air consumption of locomotive auxiliary devices.
(2) To obtain data for comparing the performance of metallic versus non-metallic packing in reverse gears.
(3) To devise a satisfactory method for testing auxiliary devices on locomotives.
(4) To submit a suitable test code for testing auxiliary devices on locomotives.
(5) To suggest and recommend suitable limits for rates of air consumption of auxiliary devices to serve as a maintenance standard and to condemn defective devices out of service.

The larger portion of the data collected and analyzed by the committee were in connection with standing tests, i. e., tests made to determine the rate of air consumption of auxiliary devices with the locomotive standing in the roundhouse. A total of 497 such tests were made on as many devices. These tests involved 111 locomotives as found on 12 railroad systems. It was necessary in every case to convert the results obtained on the test basis of 60 lb. air pressure to a basis of 100 lb., the nominal main reservoir pressure so widely used in freight service.

The first work done was to devise a method of test and prepare a suitable test code so that it would be possible to direct the making of the standing tests at different localities in a systematic and uniform manner. The test code was sent out to about 30 members, with a request that standing tests be made of all kinds of auxiliary devices in use. In every case where the recipients were able to comply with this request, a number of tests were made in strict accordance with the code, and no special difficulties were reported either in following out the method of making the tests or in computing the results.

With this code the committee sent out a tentative set of condemning limits which were arbitrarily chosen in an attempt to compromise between the degree of perfection possible to attain on the one hand and what might be regarded as excessive maintenance costs on the other hand. All the standing test data has been referred to these limits elsewhere in this report, and while this comparison shows that they would condemn a very large percentage of the devices tested, no change in the limit basis is thereby justified. It should be borne in mind that the devices tested were taken as found in service where no accurate or reliable provisions for their maintenance were in force. Under conditions of systematic maintenance much better results would be obtained and it is not improbable that the limits here suggested could be materially reduced before passing the point of diminishing returns on maintenance investment. This, of course, is a matter which will be dictated by future experience.

The Standing Tests

The only test apparatus necessary for making the leakage rate tests specified in the code is an orifice holder with suitable orifice discs, and a test gage.

The orifice holder may be a flat lipped union pipe fitting suitable for holding the orifice disc and the necessary pipe connection for attaching it to the drain cock or any other suitable connection to the main reservoir. The orifice disc at the orifice should be 1/16 in. thick and the hole should be accurately bored, (not drilled) with sharp edges. The rim of the discs may be somewhat thicker to give strength, but the thicker part should not come nearer at any point than 3/16 in. to the orifice itself. It is preferable to make the orifice out of hard brass, bronze or monel metal. The test gage should be installed so that it will indicate the main reservoir pressure. It is not absolutely necessary because the regular brake equipment gage in the locomotive cab can be used. Any inaccuracy in the gage employed is eliminated, provided the test comparison is always made at the same pressure. This is because the nature of the test is to compare the flow of air due to leakage with that through a known orifice.

TABLE I—FORM FOR THE TABULATION AND COMPUTATION OF TEST RESULTS

Loco. No.......... Class.......... Div........... Date..........

METHOD:	Compressor type and orifice diameter: Make and size of compressor	Dia. of orifice, in.	Air press., lb.	
Throttle compressor steam valve until 60 lb. air pressure is just maintained in main reservoir. Count compressor speed in single strokes per minute.	West., 9½ in.	11-64	60	(Orifices are the same as used for I. C. C. compressor condemning tests).
	West., 11 in.	3-16	60	
	West., 8½ in. C. C.	9-32	60	
	N. Y., 2-a	5-32	60	
	N. Y., 6-a	13-64	60	
	N. Y., 5-b	15-64	60	

	Tests: Compr. speed single strokes per min.: Leakage only*	Lkg. plus orifice*	Lkg. plus device	Computation of results: Compr. strokes per min. due to: Orifice only	Device only	Per cent of strokes. Col. 6, col. 5
1	2	3	4	5	6	7
Reverse gear, ¼ forward	......	......	......	......	......	......
Bell ringer, on..	......	......	......	......	......	......
Ash pan, Open...	......	......	......	......	......	......
Ash pan, Closed.	......	......	......	......	......	......
Sander (per each 3-32-in. orifice)	......	......	......	......	......	......
Cylinder cocks, Open..	......	......	......	......	......	......
Cylinder cocks, Closed.	......	......	......	......	......	......
Water scoop, Lowered.	......	......	......	......	......	......
Water scoop, Raised...	......	......	......	......	......	......
Fire door, Open ...	......	......	......	......	......	......
Fire door, Closed ..	......	......	......	......	......	......
Coal pusher, on..	......	......	......	......	......	......

NOTE:

(a) Where the locomotive is equipped with two compressors the counting of compressor strokes will be easier if one compressor is cut out.

(b) Where the leakage is so slight that it is difficult to accurately count the compressor strokes it is permissible to create a leak to increase compressor speed provided it is left unchanged during all three tests.

(c) Where the locomotive is equipped with an auxiliary device reservoir and governor it will be necessary to remove the auxiliary devices governor main valve while tests are being made.

*Cols. 2 and 3 give single observation for all tests as leakage and orifice are constant for all tests.

Col. 5 is the difference between cols. 3 and 2.
Col. 6 is the difference between cols. 4 and 2.
Col. 7 is col. 6 divided by col. 5.

The determination of the leakage rate for each auxiliary device tested will depend on the results of three tests. However, two of these tests will always be common to all devices tested on the same locomotive, so that after the first device is tested only one test will be required for each succeeding device tested on that locomotive. The methods of making the tests and the computation of results are briefly outlined in Table I, which shows a convenient form for recording the data.

In making the tests, close the compressor steam throttle valve, cut out the main reservoir supply to all air operated

*Abstract of a committee report and discussion, presented at the twenty-seventh annual convention of the Air Brake Association, held at Chicago, May 4-7, 1920.

†The term "air operated auxiliary devices" as used in this report refers to all air operated devices on locomotives which are not a part of the air brake system.

auxiliary devices, and see that the drain-cock at the orifice fitting is closed. Reduce main reservoir air pressure down to some value lower than 60 lb., preferably about 55 lb. Open the compressor throttle slowly until the compressor raises the main reservoir pressure and is just able to maintain it at 60 lb. When this condition has been reached for a time of about three minutes so that the tester can be sure that a true balance of the pressures has been obtained, the compressor speed in single strokes per minute will be counted. The count will be entered in column 2, under the heading "Leakage only."

The second test will be made in the same manner except that the drain cock leading to the orifice will be open. This will mean that in addition to the leakage, the compressor will have to maintain the main reservoir pressure at 60 lb. against the air passing to atmosphere through the orifice. Enter the compressor speed in column 3, which is headed "Leakage plus orifice."

The third test will be made in the same manner as the first and second tests except that the orifice fitting will be cut out and the particular auxiliary device to be tested will be cut in. The compressor speed will be entered in column 4. headed "Leakage plus device."

The computations are clearly indicated on the form and the final comparison for each device is expressed in per cent of strokes per minute required to supply the orifice.

Condemning Limits

It will be observed that the type of compressor with which the locomotive is equipped will determine the size of the orifice used. The orifice sizes chosen are the same as those specified by the well known Interstate Commerce Commission compressor condemning tests and can, therefore, be used for testing both compressors and auxiliary devices. These orifices and a suitable orifice fitting are always available at roundhouses and other places where the compressor tests are made.

Table II—Limits Recommended for Condemning Air Operated Auxiliary Devices on Locomotives

Device	Percentage of orifice strokes allowed					
	9½-in. comp., 11/64 in. orifice	11-in. comp., 3/16-in. orifice.	8½-in. C. C. Comp., 9/32 in. orifice	2-a comp., 5/32-in. orifice	6-a comp., 13/64 in. orifice	5-b comp., 15/64-in. orifice
Reverse gear, ¼ forward...	31.2	26.6	11.6	38.2	22.6	17.0
Bell ringer, on...........	9.3	8.0	3.5	11.4	6.8	5.1
Ash pan, open and closed..	46.8	40.0	17.4	57.2	33.8	25.4
Sander (per each 3/32-in. orifice)	31.2	26.6	11.6	38.2	22.6	17.0
Cylinder cocks open and closed	31.2	26.6	11.6	38.2	22.6	17.0
Water scoop, lowered and raised	62.5	53.3	23.2	76.3	45.1	34.0
Fire doors, open and closed.	15.6	13.3	5.8	19.1	11.3	8.5
Coal pusher, on...........	62.5	53 3	23.2	76.3	45.1	34.0

Table II gives the limiting values of percentages as computed in column 7 of the previous table. A value is given for each kind of auxiliary device when tested under the six different combinations of compressor and orifice size. Whenever the percentage of strokes found in column 7, Table I, exceeds the corresponding value given in Table II, the device in question should be condemned and ordered for necessary repairs.

Table III—Air Consumption Equivalent to the Condemning Limits

Device	Leakage rate in cubic feet of free air per minute		
	At 60 lb. pressure	At 100 lb. pressure	At 140 lb. pressure
Bell ringers	3	4.6	6.2
Fire doors	5	7.7	10.3
Cylinder cocks	10	15.3	20.7
Reverse gears	10	15.3	20.7
Sander (per each 3/32-in. nozzle).......	10	15.3	20.7
Ash pan	15	23.0	31.0
Water scoops	20	30.7	41.3
Coal pushers	20	30.7	41.3

The leakage rates in cu. ft. of free air per minute equivalent to the condemning limits suggested above are shown in Table III.

The results of the standing test data are shown plotted in a convenient form in Fig. 1. The average maximum and minimum values for leakage are given for each condition under which the various devices were tested, and it is shown on the basis of 100 lb. main reservoir pressure. The corresponding test code leakage limit value is also shown for each device. The data shown are the most complete information of its kind in existence and can be regarded as a true index to the general condition and performance of auxiliary devices.

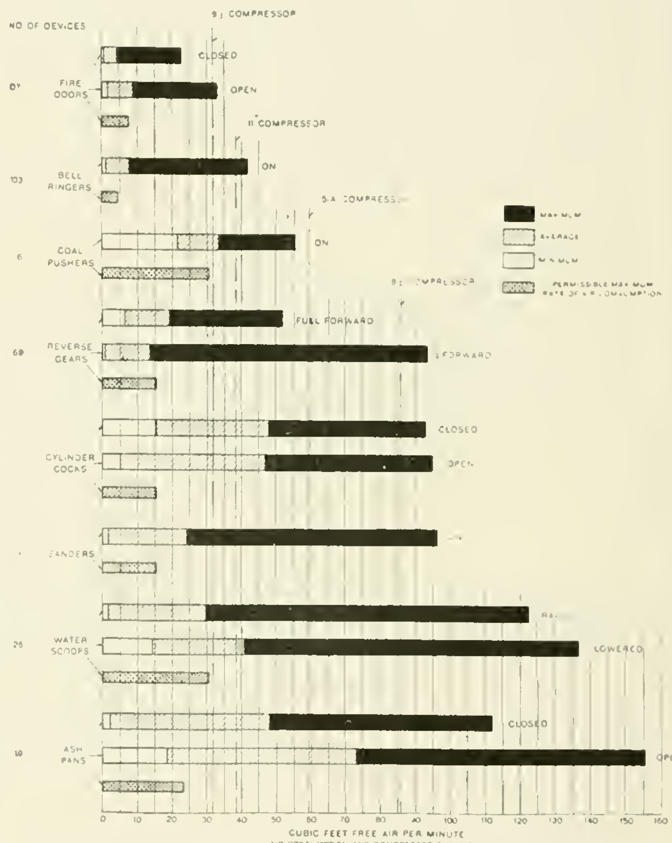


Fig. 1—Air Consumption of Auxiliary Devices of Locomotives Determined from Tests of 111 Engines

Table IV gives the result of applying the recommended condemning limits on all devices tested, more than half of which would thereby be condemned.

Table IV—Effect of Applying Condemning Limits to the Devices Tested

Device	No. tested	No. passed	Per cent passed	Per cent failed
Reverse gears	68	47	69	31
Bell ringers	103	48	47	53
Ash pans	19	4	21	79
Sanders	136	46	33.8	66.2
Cylinder cocks	32	4	12.5	87.5
Water scoops	26	11	42	58
Fire doors	107	50	47	53
Coal pushers	6	3	50	50
Totals	497	213	42.9	57.1

Running Tests of Power Reverse Gears

To determine the air consumption rate for reverse gears when running in service, a very complete program of tests covering a period of about five weeks' work was outlined. It was impossible to carry out the program fully, but service runs were made with 21 locomotives which were distributed

on four divisions of three railroads. The data for these tests are shown in Table V.

The curves for three tests are plotted in Fig. 2. These curves represent respectively the worst gear tested, the best gear tested and the retest of the worst gear after it had been repaired to correct the leakage.

It will be noted that the tests included 15 gears having metallic packing and 6 gears with non-metallic packing. The tests were made without any special regard for either type of packing and show a distinct difference in the quality of service in favor of the metallic packing. This is evident from the average miles of service per cu. ft. of average leakage developed. The figures show that where the non-metallic packed gears made 249 miles for each cu. ft. per min. leakage developed the metallic packed gears made 2,491 miles, a ratio of just 10 to 1 in favor of metallic packing. The number of gears tested, however, is not sufficient to warrant final conclusions.

The Field for Profitable Maintenance

The general aspect of all the test results indicates that the air operated auxiliary devices are in a more or less uneconomical condition. They undoubtedly perform the intended functions in a very satisfactory manner, but only at the cost of compressed air. This cost is much greater than it need be, and the problem of reducing it to a minimum resolves itself into the determination of how much maintenance expense will be warranted. The test figures show a wide field for profitable investment in maintenance, and better maintenance will carry with it other betterments, such as less wear and tear, more perfect performance, and greater reliability, all of which will tend to turn to raise the efficiency of locomotive operation. The proposed condemning limits will serve to reduce the waste at least one-half, and when this saving is accomplished the association will be in a position to scale the limits downward on a scientific basis, because it will then have available actual maintenance cost figures.

The committee fully realized the importance of attacking this subject on a cost basis, but certain necessary service factors remain to be determined in a more accurate and reliable manner before such comparisons could be justified. A knowledge of maintenance costs would also be necessary to a complete analysis of the costs involved.

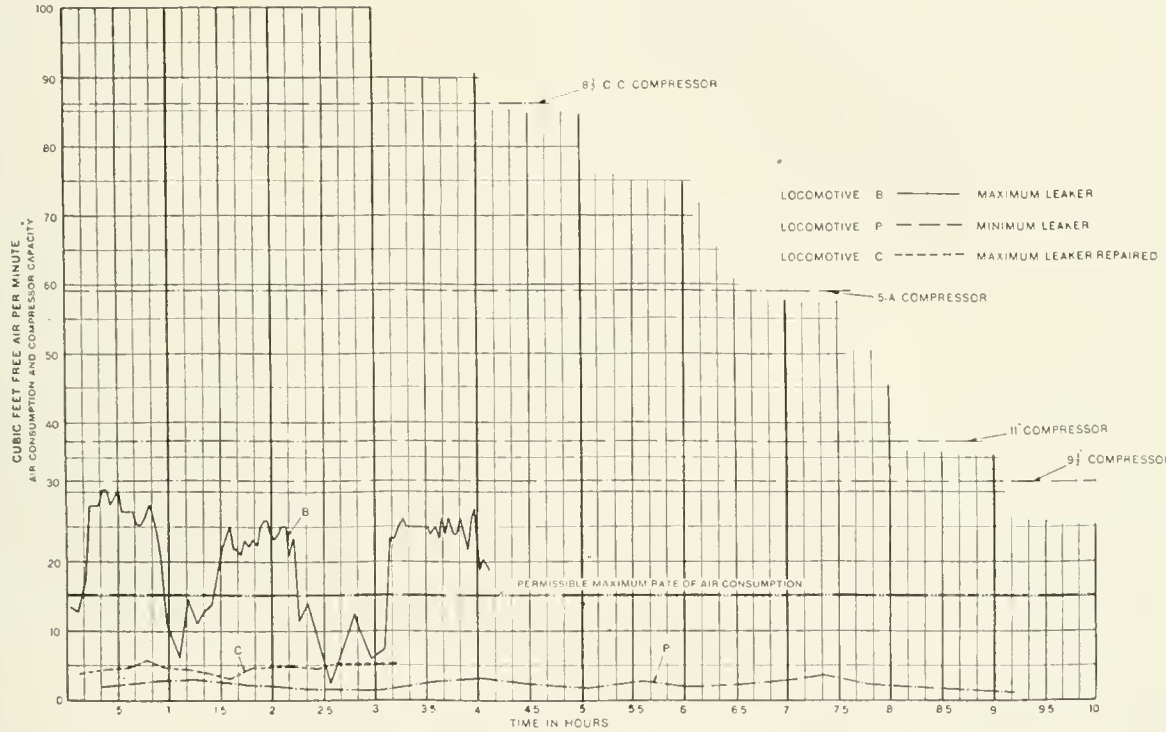


Fig. 2—Air Consumption Curves for Power Reverse Gears on Freight Locomotives in Road Service

Table V—Summary of Reverse Gear Running Tests

(Leakage based on 100 lb. main reservoir pressure.)

Locomotive	Type of ragonnet reverse gear	Kind of packing	Leakage, cu. ft. free air per min. Max.	Min.	Average	Total cu. ft. free air used during trip	Mileage from application of packing to date of test	Miles per cu. ft. per min. average leakage	Average
A	A	Non-metallic	29	4.9	13.8	6642	2,455	178.1	
B	"	"	30.5	2.2	22.1	5527.5	3,692	166.9	
C	"	"	5.9	3.2	4.7	927 9	1,002	215.4	249.2
D	"	"	4.9	3.1	3.9	696.5	2,500	628.8	
E	"	"	24 4	5.5	13.1	3519.4	2,356	179.5	
F	"	"	9.4	4.5	6.2	1081.2	784	126.6	
G	"	Metallic	13	4.3	7.7	2969.4	24,085	3139	
H	"	"	9.8	6	6 9	2305.3	26,058	3730	
I	"	"	60.9	4	17.5	7329	16,893	968.1	
J	"	"	24.4	12.2	20.9	5093.2	3,729	177.9	
K	"	"	9.6	2.1	6.7	2230.4	1,526	229.2	
L	"	"	4.9	3.9	4.4	1280.3	206	46.7	
M	B	"	26.1	5.1	18.7	3543.5	18,000	965.2	
N	"	"	23.2	4	12.8	3358.5	20,000	1566	2491.3
O	"	"	11.3	3.9	6.2	1225.3	18,000	2926	
P	"	"	3.6	1.4	2.3	1313	19,000	8422	
Q	"	"	62.6	5.8	13.8	2387	16.000	1156	
R	"	"	14.3	1.1	9.8	3047.4	29.564	3010	
S	"	"	21.5	2.8	17.1	3356.4	26,487	1548	
T	"	"	5.6	1.8	3.7	886.6	32,007	8594	
U	"	"	32.9	1.8	18.7	2776.8	16,678	891.3	

However, some of the facts demonstrated by the data have an important bearing on how much it is costing the railroads to operate auxiliary devices as compared to what it really ought to cost. In other words, it is possible to point out, on the basis of compressed air used, the probable margin of saving that could be effected by a reasonable maintenance program, from which it is comparatively easy to decide how much maintenance expense is warranted.

The data presented in Fig. 1 cover all the different kinds of devices tested. It is not permissible to base a comparison on all of the devices listed because several of them are not subject to constant use while the engine is in service. For the purpose of this comparison only three kinds of devices are chosen; namely, bell ringers, fire doors and reverse gears. It is assumed that the respective average rates of air consumption found for these three devices in the standing tests are characteristic of their average condition in service.

It can also be assumed that if these devices were maintained within the maximum rates of air consumption fixed by the test code limits the average leakage could be held to not more than one-half that represented by the limits. The actual figures for such a comparison are given in Table VI.

TABLE VI—ACTUAL AND POSSIBLE RATES OF AIR CONSUMPTION OF BELL RINGERS, FIRE DOORS AND REVERSE GEARS.

	Average-rate in cu. ft. per min. at 100 lb. main reservoir pressure. Actually found during tests	Insured by test code limits
103 Bell ringers	7.75	2.30
107 Fire doors	6.80	3.80
68 Reverse gears	16.57	7.60
Totals	31.12	13.70

It will be evident from the above table that locomotives equipped with the three devices listed would supply 31.12 cu. ft. of free air per minute to operate these devices, whereas if the devices were maintained within the test code limits the air requirement would only be 13.70 cu. ft. of free air per minute. This difference is decidedly impressive when

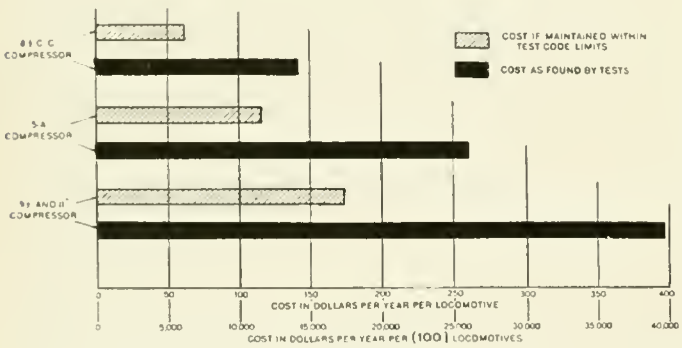


Fig. 3—Annual Cost of Compressed Air Used by Three Auxiliaries and the Portable Cost Under Proposed Condemning Limits

expressed in terms of the money value of compressed air. Such a comparison is shown in graphic form by Fig. 3. The cost values were computed from the data by using the following assumptions, which are commonly accepted as conservative for the factors involved:

1. That the average working time for locomotives is 6 hours per day or 2,190 hours per year.
2. That the average evaporation rate for locomotives will be seven pounds of water per pound of coal.
3. That the rate of steam consumption per 100 cu. ft. of free air compressed to 100 lb. pressure will be for the 9½-in. and 11-in. compressor, 68 lb.; for the 5-A compressor, 44.7 lb.; for the 8½-in. C. C. compressor, 24 lb.; based on actual steam consumption tests.
4. That the price of coal on the tender is $2.00 per ton.

The two extremes of the comparison in Fig. 3 can be pointed out as follows:

1. On basis of 100 locomotives having 8½ in. C. C. compressors, the cost per year without maintenance would be $14,000, and with maintenance, $6,170, leaving a margin of $7,830 for reduction of expense.

2. On basis of 100 locomotives having 11 in. compressors, the cost per year without maintenance would be $39,700, and with maintenance, $17,480, leaving a margin of $22,220 for reduction of expense.

The assumption of coal cost as $2 per ton on the tender is much too low to represent the actual average cost of coal. The reason this value was taken was to make it easy to convert the cost figures to correspond to any price paid for coal. It would not be unreasonable to contend that the average cost of coal on the tender is about $5 per ton, and in such event the costs and margin for economy would be two and one-half times greater than those given in Fig. 3. Likewise, it should be remembered that these figures are based on only three devices, all the others being ignored, although many locomotives have them. Those devices are, therefore, an additional source of compressed air waste, which was omitted in this comparison because no accurate data were available, and because its omission is in the direction of making the cost values more conservative. Other cost increasing factors, such as wear and tear on the compressor plant, cost of water, labor, etc., were also omitted, because exact data were lacking.

Discussion

It was very evident from the discussion of this report that few of the members of the Air Brake Association have realized the seriousness of the losses from air leakage in connection with the operation of auxiliary devices on locomotives as they are generally maintained. Some of the members, who had applied the tests recommended by the committee for the purpose of securing data to be used in the preparation of the report, testified as to their efficacy in bringing to light conditions causing excessive air consumption, which might otherwise continue indefinitely so long as the apparatus functions without positive failure. No objections were raised as to the practicability of the tests themselves, their simplicity and the ease with which inspectors may be trained to make them being commented on generally by those who have already tried them out. There was some difference of opinion, however, as to the proper time and intervals for their application. The committee offered no recommendation on this point, but left it to be worked out by the members as individual conditions and experience might dictate.

In discussing the cost of excessive leakage, the committee considered only those devices which are usually under constant pressure. It was brought out in the discussion that, while devices such as water scoops do not cause a serious waste of air in the aggregate because of their infrequent operation, they do draw heavily on the air supply when operating, and when neglected, excessive leakage may result in undesired applications of the brakes or inability to release the brakes, so that from this standpoint their maintenance is of equally as great importance as that of the more frequently operated devices.

The committee was continued to report at the next convention what progress has been made in establishing the tests and to what extent they have led to improved conditions. A suggestion was also offered to the executive committee that measures be taken to bring the paper to the attention of the American Railroad Association, Section III-Mechanical.

COOLING COMPOUNDS FOR CUTTER SHARPENING.—The cooling compound for wet grinding is a question on which there is considerable difference of opinion. Water is about as good a coolant as can be obtained, but it has the disadvantage of rusting the moving members of the machine. A cooling compound which has been used with good results is soda water. This comprises one pint of sal soda to 10 quarts of water. The solution is mixed cold and applied in the usual manner.—Grits and Grinds.

MACHINE TOOL

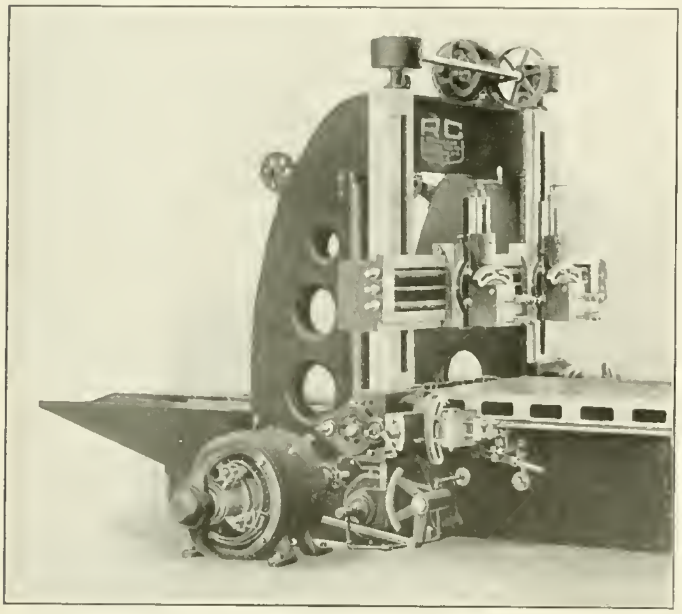
AND

SHOP EQUIPMENT

SECTION

High Power Multispeed Planing Machine

MECHANICAL engineers conversant with machine tool design recognize that the real problem to be solved in planer construction lies in overcoming the inertia of the high-speed parts, which may reach a value many times that of the massive table loaded with work. This inertia must naturally all be absorbed by the belts or motor at the moment of reversing. In the planing machine, illus-



View Showing Motor Drive Arrangement

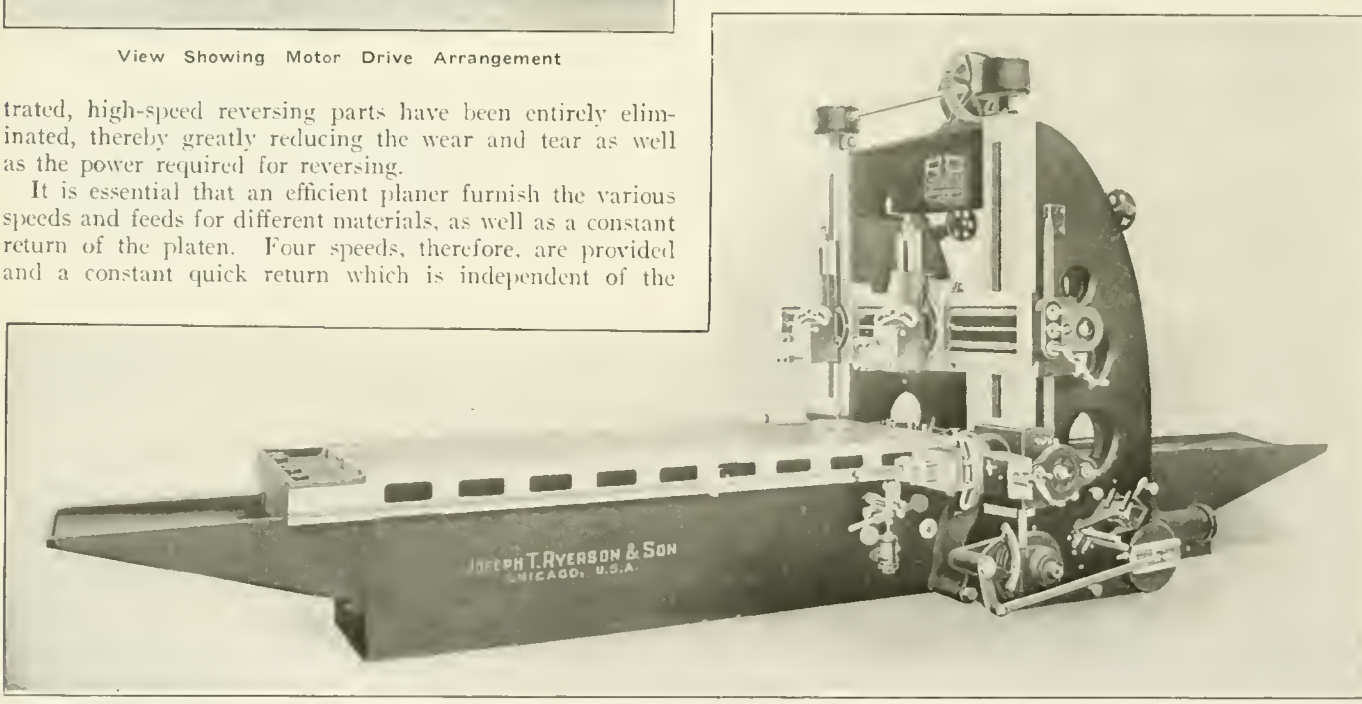
trated, high-speed reversing parts have been entirely eliminated, thereby greatly reducing the wear and tear as well as the power required for reversing.

It is essential that an efficient planer furnish the various speeds and feeds for different materials, as well as a constant return of the platen. Four speeds, therefore, are provided and a constant quick return which is independent of the cutting speeds. For general machine shop work, cutting speeds of 25, 30, 37½ and 45 ft. per min. are provided in the heavier types, with a return speed of 100 ft. per min., all of which may be varied to suit requirements.

The motor is directly connected to the main drive shaft by a Clark flexible coupling. The primary shaft carries two-spool gears, and on the extreme end of this shaft the reversing pinion engages directly with the return clutch gear. The change gears are mounted on a square shaft and are shifted by a lever mounted in a gridiron. The pinion on this shaft meshes with the forward clutch gear, thereby giving four cutting speeds.

In order to provide a smooth, durable reversing mechanism, a special form of annular pneumatic clutch has been adopted, as this type is self-compensating for wear and requires practically no attention. Dogs on the platen trip the distributing valve, alternately admitting air to one or the other of the clutches. As a spacing rod connects the two, one is forced out when the air is admitted to the other, making it impossible to lock the drive gearing. The reversing of the clutch shaft is accomplished in this manner. The back gears, bull pinion, bull wheel, and rack are of herringbone design. This method of driving has been adopted, as it is difficult to build a machine with spur or spiral gearing that, for any length of time, will be free from showing a tooth mark. The chief advantages of herringbone rack and gear drive are continuous smooth operation, greater resistance to wear, reduction of back lash, and increased strength of the teeth. All gears and bearings are automatically oiled by the splash system, and the overflow of lubricant returns to a central tank by gravity.

The planer bed is of box section type, thoroughly reinforced. The wide supporting surface of each V is inclined 15 degrees to the horizontal, permitting the formation of a uniform oil film under the most severe conditions. The inner leg is inclined 15 degrees to the perpendicular, functioning as a guideway. The proportioning of the two is such that the wear is self-compensating. The pockets for lubricating the ways are automatically filled with the oil carried up by the bull wheel. Each end of the bed carries a large apron extending beyond the maximum travel of the table for catching all surplus oil which, after filtering, returns to the central tank by gravity.



Ryerson-Conradson Planer With Pneumatic Feeds and Reversing Clutch

The driving mechanism of the rack feed constitutes a departure from customary practice. A piston, operated pneumatically turns the feed regulating disk through 180 degrees, the crank of the disk being connected with levers to a gear segment, raising and lowering the feed rack. The moment

the table trips the air distributing valve, air is admitted alternately to one of the clutches as well as the corresponding end of the rack feed piston.

The cross rail elevating screws are driven by a motor mounted on a cross girth, the entire elevating mechanism consisting of spur reduction gears and a set of bevel gears, the latter placed directly on the elevating screw. The cross rail is of standard construction, permitting individual traverse and feed of each head in either direction. The heads on the cross rail and both side heads have power angular feed and are of extra heavy design. The side heads have power vertical traverse the full length of travel, and also power feed at any angle.

To operate the clutches and rack feed piston, compressed air is required, the pressure recommended being 80 to 100 lb. per sq. in. The air consumption of the planer is exceptionally low, ranging from 3 to 10 cu. ft. of free air per min. from the smallest to the largest size planer. For shops not having a compressed air system, suitable means are provided for connecting a small standard compressor directly to the main drive shaft.

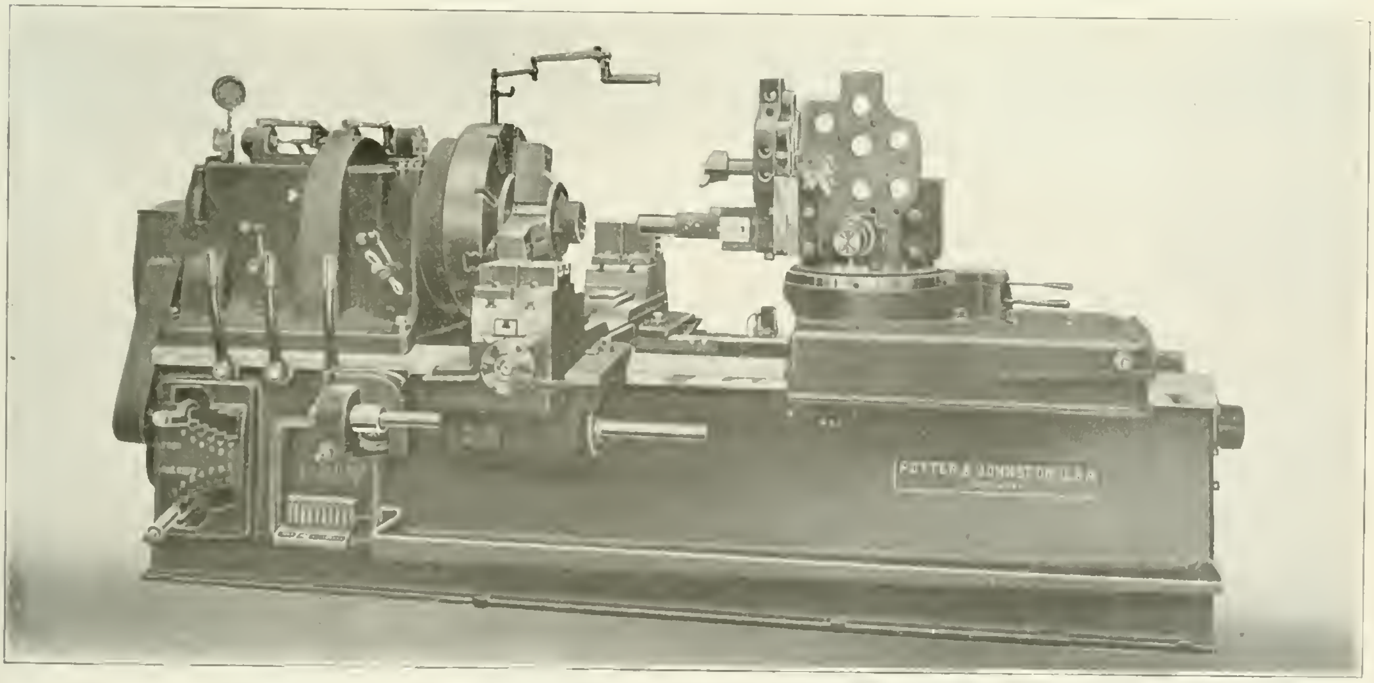
The planer described can be furnished in four sizes from 24 in. by 24 in. to 48 in. by 48 in. Driving motors varying from 3 hp. to 25 hp. are required, depending on the character of the work to be done. The machines have been placed on the market by Joseph T. Ryerson & Son, Chicago, Ill.

Automatic Chucking and Turning Machine

A NEW automatic chucking and turning machine, called the 8-B, has been developed by the Potter & Johnston Machine Company, Pawtucket, R. I. It is built with a geared automatic change speed head, and the spindle driving mechanism is all contained in the headstock, which is of unit construction. The machines are heavy, powerful and accurate, well suited to the manufacturing of multiple parts as in modern railway shops. The drive is by a single pulley transmitting 20 hp.

Four combinations of six automatic variations of speed are available, giving 24 spindle speeds in geometric progression from 6 r.p.m. to 92.5 r.p.m. Any one of these combinations may be instantly obtained by levers conveniently located on the headstock. The gearing for driving the spindle is self-contained within the headstock, all gears running in oil, which is pumped through all bearings. A gear on the spindle takes care of the higher spindle speeds, while the lower ones are taken care of by a gear fastened to the chuck or face plate.

The feed gearing is driven from the spindle. There are seven combinations of three automatic variations of feed, making a total of 21 feeds from .005 in. to .125 in. per revolution of the spindle. By changing one train of gears conveniently located on the outside of the machine, the range of feeds may be doubled. The hand changes for the feeds are obtained by means of tumbler levers, conveniently located at the front of the machine. The ratio of the second feed to the first feed is constant. The third feed is independent of the first two, and any desired combination may be obtained. The changes obtainable on the machine give the proper lead for cutting from 20 to four threads per inch, using automatic collapsing taps or automatic opening die heads. Any one of the three feeds can be obtained automatically at any time. The feeds are independent of the high constant speed for idle movements of the turret slide while withdrawing, revolving and advancing the tools to the point of cutting.



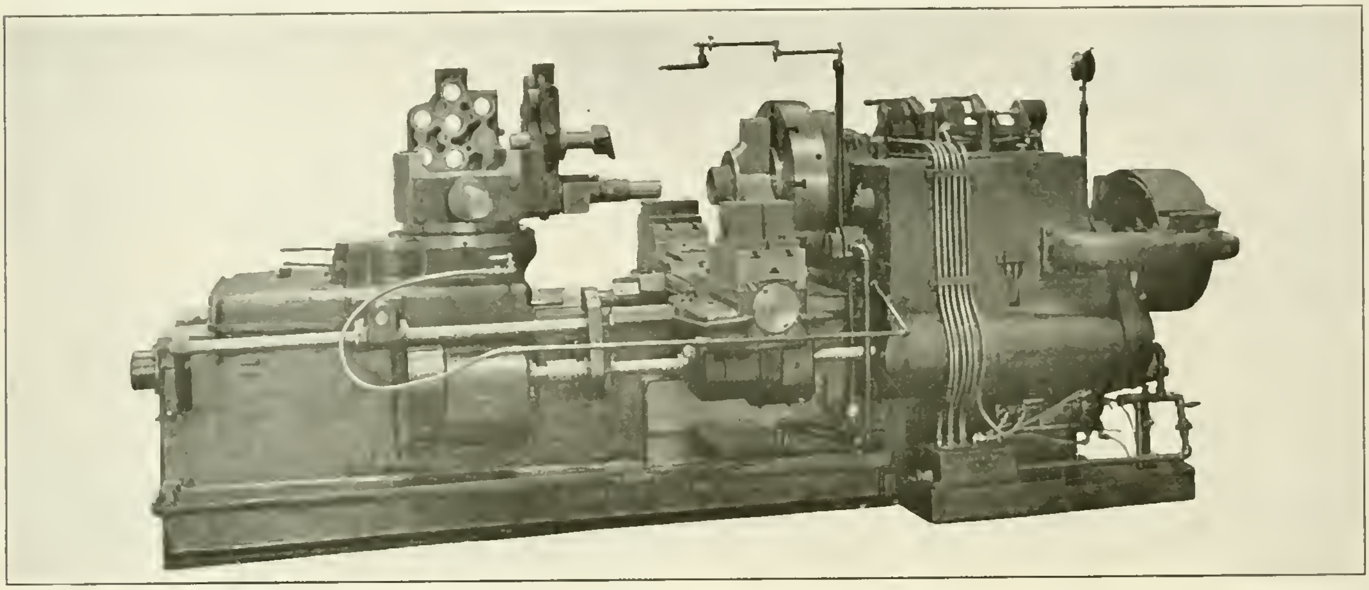
Potter & Johnston No. 8-B Manufacturing Automatic

The cross slide is provided with front and rear blocks and two pairs of tool posts are furnished with each machine. The front and rear cross slide operate independently by screw feed, having a feed of 10 in. and can be arranged to feed into the work at any predetermined time, and at any desired relation, one to the other. The turret slide is of rugged construction and travels on ways so designed that all wear will be even and will not affect the accuracy of the machine. The turret slide has a 28-in. feed and no allowance needs to be made for revolving, as the turret revolves at the extreme end of its travel. It has 13-in. lon-

gitudinal adjustment by means of a hand crank and is securely clamped in any desired position by three bolts, besides being located by the adjusting screw.

The turret has four stations upon which tools may be mounted, and with each machine an outfit of turret turning tool holders, stems and cutters is furnished. Turrets with five or six faces may be furnished if desired. The turret is revolved by power through an intermittent pinion and gear and is so designed as to give an easy stop and start, the turret being stopped when the lock bolt engages, thus removing any shock from the lock bolt. It is clamped into position by a powerful binder working on the largest diameter of the turret seat. Levers are conveniently placed to release the binder and lock the bolt so that the turret can be revolved by hand. Both cross and turret slides are adjusted in relation to each other by conveniently placed clutches.

All operation of the speed clutches, feed and quick return clutches is done by a patented method, operated by dogs located on the dog wheel or drum. This method gives instantaneous movement to the clutches and enables the feed, speed and quick return to begin at exactly the same place each time. An oil pump and piping and oil arrangement through the turret are furnished on machines handling material requiring a lubricant. A 24-in. three-jaw geared scroll chuck regularly accompanies the machine and is furnished with standard set of jaws and wrench. The chuck is provided with pilot bushings to receive pilot bars for supporting the tools during the cutting operation.



Rear View Showing Cutting Lubricant and Oiling Systems

A swing of 35 in. is possible over the machine bed and 24 in. over the cross slide. The travel of the cross slide (front and rear separate) is 10 in. A 15-hp. motor is required to drive the machine, when motor driven.

Universal Index Centers With 10-In. Swing

A UNIVERSAL index center made to swing work up to 10 in. in diameter has been placed on the market recently by the Simmons Machine Company, Albany, N. Y. This index center is shown in Fig. 1 with two extra index plates in the foreground. The spindle has a No. 10 B. & S. taper. The swivel block is graduated and the worm wheel diameter is five inches. The head and tailstock are regularly furnished with tongues 5/8 in. wide, but any width of tongue may be specified. The equipment includes three index plates, four 5/8-in. bolts, wrenches and an index chart.

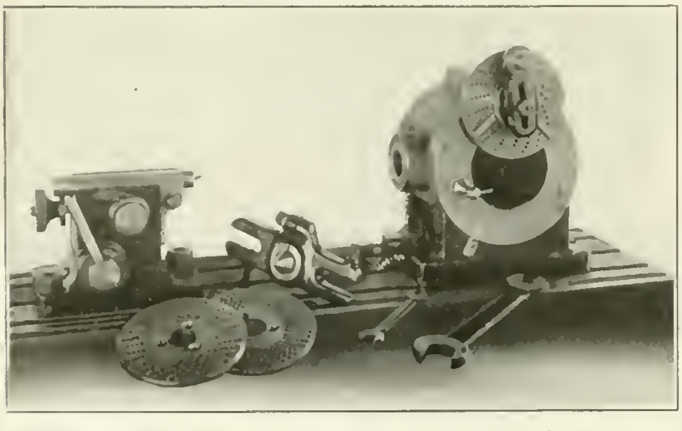


Fig. 1—Simmons 10-In. Universal Index Center

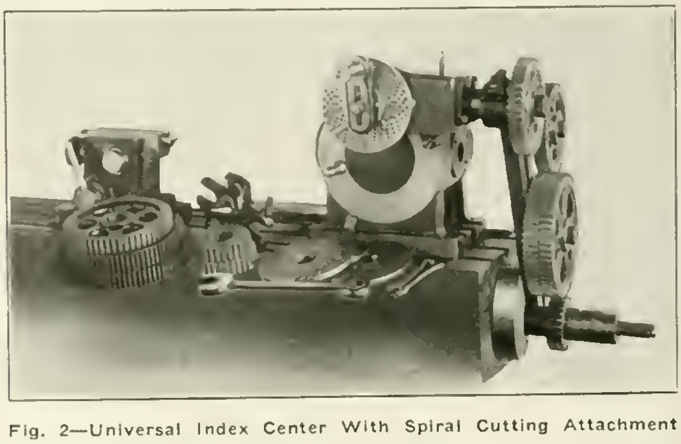


Fig. 2—Universal Index Center With Spiral Cutting Attachment

If desired, the index center can be provided with a spiral cutting attachment illustrated in Fig. 2. By removing the extension arm, the head can be swung 90 deg. The front end is threaded 2 5/16 in., and has a 1 1/16 in. hole through

the entire length. The index crank is adjustable and all bushings are hardened. The gears are ¾ in. thick and have 1¼-in. bores. The equipment furnished is the same as previously mentioned. The Simmons dividing heads or index centers may be used on any standard milling machine adapted to tool room work.

Air Operated Combination Three-Jaw Chucks

There is undoubtedly a big field for the use of air operated chucks in railway machine shops, especially those that have been modernized and placed on a production basis. Probably the most useful application at the present time is to turret lathes, and Fig. 1 shows a three-jaw, air operated chuck thus applied. This chuck holds the work more securely than one operated by hand, which makes possible heavier cuts and increased feeds. There is also a big saving in chucking time and a resulting increase in production. The Logan chuck, illustrated, is being placed on the market by Frank E. Payson Company, Chicago, Ill., and is adapted to all types of lathes. The weight on the spindle is evenly balanced and the overhang is reduced to a minimum. The one-piece body construction gives ample strength. The improved jaw operating mechanism reduces friction and wear and insures a positive grip on the work that will hold under severe cuts and feeds. Dustproof joints between the draw tube and jaw slide keep dust and chips from working into the operating mechanism.

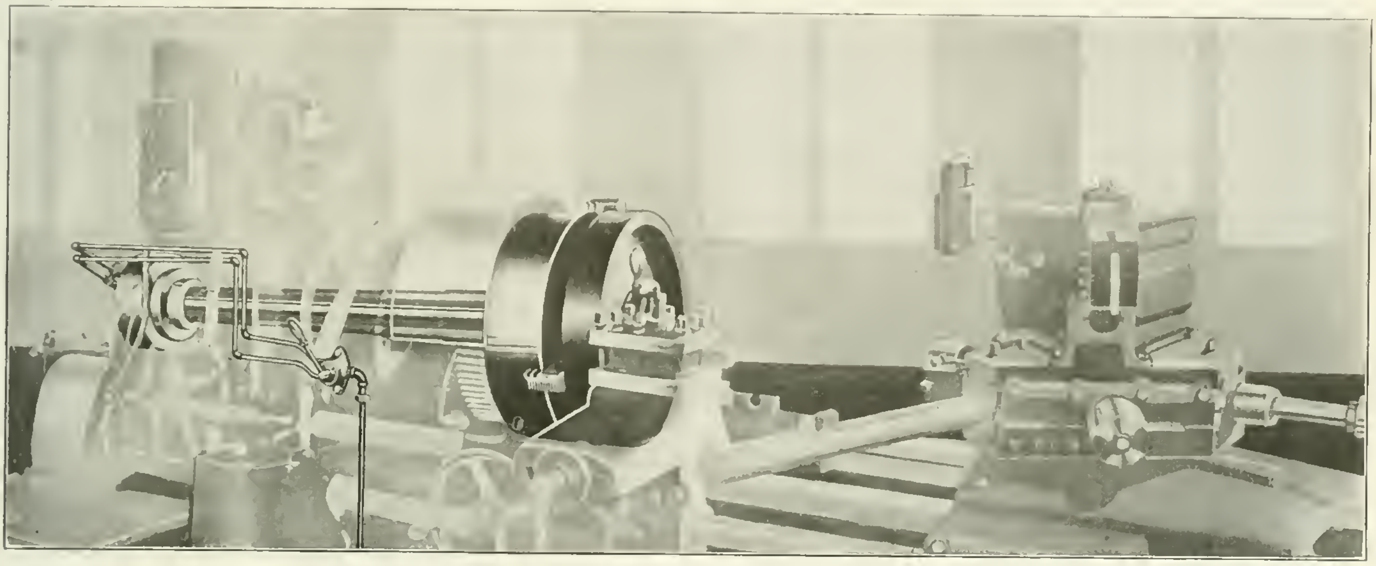


Fig. 1—Logan 24-in. Air Operated Chuck Applied to Heavy Duty Turret Lathe

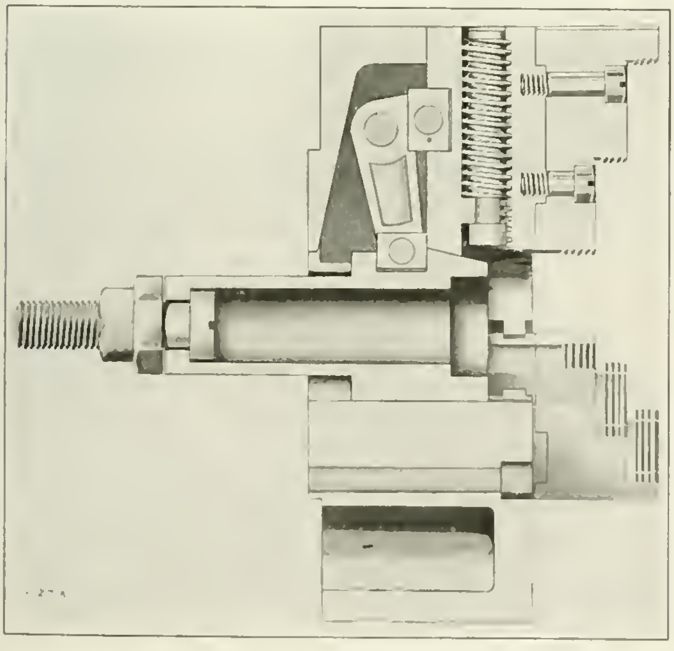


Fig. 2—Cross Section of Combination Three-Jaw Chuck

The combination three-jaw chuck, illustrated in Fig. 2, is provided with jaws which are adjustable and reversible. They can be set independently by a wrench or universally operated by compressed air in connection with the Logan double acting air cylinder. Master jaws with plain, soft steel blocks are regularly fitted to a steel or semi-steel body. A set of three-step reversible hardened steel jaws to fit the

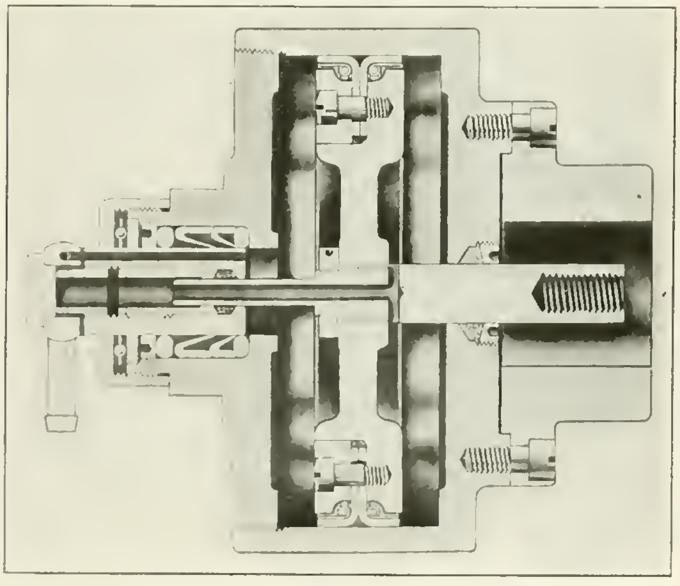


Fig. 3—Logan Double Acting Air Cylinder

master jaw can be provided if required. Attention is called to the one-piece body construction, the convenient, adjusting screw, the chrome nickel steel lever, and the fact that the draw tube and jaw slide do not separate, making a dust proof joint.

A cross section of the double-acting air cylinder, Fig. 3, shows the Johns-Manville type of packing cup and expander ring. The general arrangement of the cylinder is indicated and it is stated that leaking in the air shaft, a prevalent trouble, particularly in high speed machines, has been entirely overcome. This cylinder can be used on a machine running at a constant speed of 1,500 r. p. m. without overheating or requiring much attention. When the air is applied it enters an air channel between the outside of the piston and the inside of the expander ring, increasing the pressure against the cylinder bore and preventing air leakage.

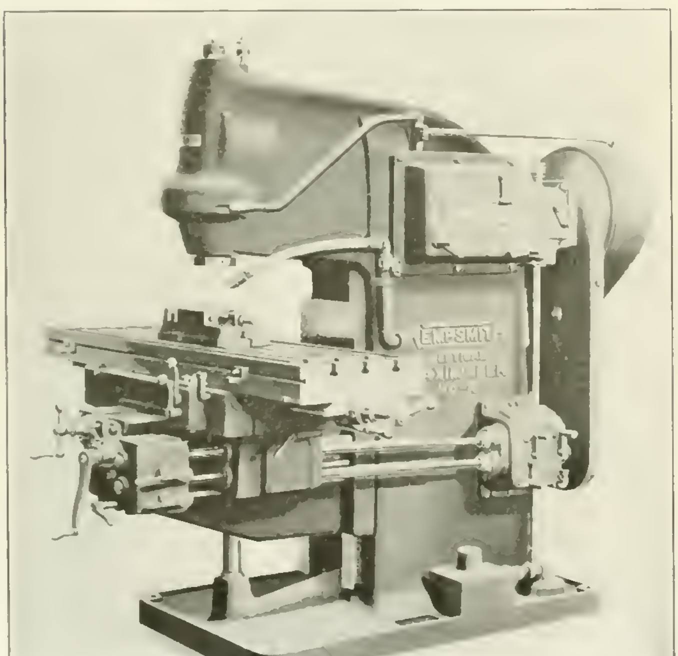
The air valve is shown in Fig. 1 and consists of a semi-steel body with a hand-lapped bronze taper plug operated by the handle shown. The parts are easily accessible for oiling or cleaning without disconnecting air pipes. A reversible handle enables the valve to be located in any desired position on the machine.

A Powerful Vertical Type Milling Machine

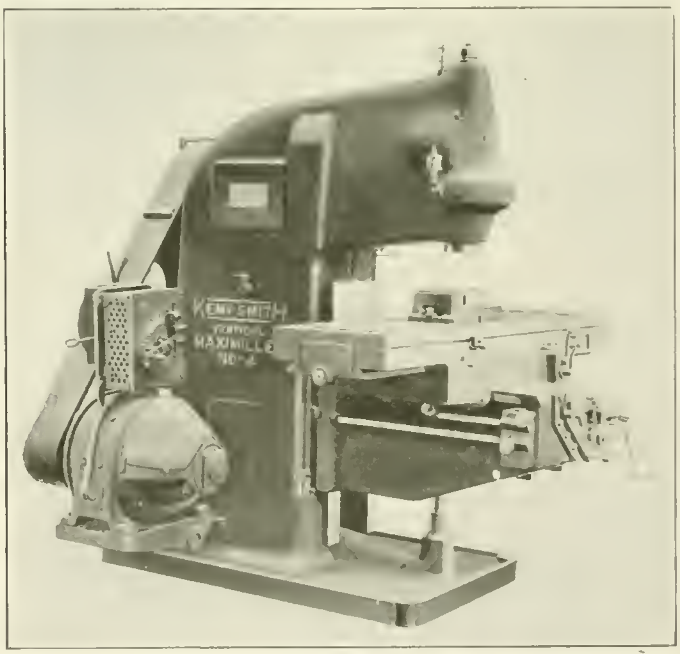
FOR many kinds of work the vertical type milling machine has important advantages over the horizontal type. With this fact in mind, the Kempsmith Manufacturing Company, Milwaukee, Wis., has designed the No. 4 vertical Maximiller which embodies several of the features of the horizontal type Maximiller previously described in the March, 1919, *Railway Mechanical Engineer*.

Special attention paid to securing a rigid machine has reduced vibration to a minimum and the entire design has been made with a view to maximum power, convenience of operation and quality of work. The main frame members of the machine, including the column, knee, saddle and table, are of semi-steel, with every effort made to secure strength without adding more metal than necessary. The column has few and small openings. It is well ribbed and has a rib midway of the column height, forming a reservoir for the speed drive oil. This rib also has a stiffening effect on the column.

The design of the knee is the same as that used on the horizontal machine, and there is no opening at the top, merely a shallow depression to receive the center drive cross feed screw. The side walls also are practically solid, having but three small openings. This solid construction serves to resist clamping strains and the torsional effects of the table overhang. The knee, table and saddle are counterweighted by means of weights inside the column. Easy vertical adjustment of the work in relation to the cutter makes an auxiliary vertical slide for the spindle unnecessary. The table has a working surface of 70 in. by 18 in. and a longitudinal range of 42 in. Table wear is taken up on adjustable taper gibs with locked adjustment. Face milling cutters may be driven in either direction and the spindle nose construction permits cutters to be set up or removed easily. A spindle reverse has been incorporated for the reason that, in order to get cutting strains in the proper direction on the gibs and tables, a face mill must be run in the opposite direction to a spiral or slab mill. The spindle reverse of this machine is controlled by a single lever conveniently located.



View Showing Machine Arrangement for Motor Drive



Kempsmith No. 4 Vertical Type Maximiller

The No. 4 Maximiller is arranged with power quick traverse, giving a 100-in. per min. travel of the table in either direction and a vertical movement of 36 in. per min. The traverse control is concentrated, and it is unnecessary for the operator to change his position in operating any of the quick traverse and feed movements. In case of error on the part of the operator in engaging wrong levers, the machine is amply protected by safety devices.

Eight changes of feed are provided, ranging from 5/8 in. to 25 in. per min. in geometrical progression. The gears are all heat treated and proper safety devices are incorporated throughout to prevent exceeding the maximum safe load. Particular attention has been paid to the question of lubrication, and the gears and shafts in the entire speed and feed mechan-

ism run constantly in oil. The balance of the oiling system is centralized at two points, so that none will be overlooked. For the circulation of the proper amount of cooling compound, a pump of 15 gal. per min. capacity has been provided.

A change in the power quick traverse rate does not affect the speed rate of the cross and vertical movements, and the quick traverse is available even if the spindle and feed are not operating. This is an advantage when setting up the machine or in returning the table after a completed cut has been taken. The machine is regularly arranged for single-pulley drive, but at an additional cost it can be arranged for motor drive through a belt, in which case a 15 h.p. motor, running at 1,200 r.p.m., is required.

The longitudinal, transverse and vertical ranges are 42 in., 14 in. and 20 in., respectively. The distance from the spindle to the table, in the lowest position, is 22 in. and the throat distance is 19 in. There are 18 spindle speeds, ranging from 14 to 355 r.p.m. Eighteen feeds are provided, which range from 5/8 to 25 in. per min. Owing to the power and convenience of operation of the No. 4 vertical Maximiller, it should be well adapted to the heavy milling machine requirements of railway shops.

Machine for Correct Tap Grinding

GRINDING a tap consists usually of grinding the taper at the end of the tap and the clearance back of the cutting edge thus formed. This taper may be long, as in nut taps, short, as in plug taps, or almost none, as in bottoming taps. The principle remains the same in each case. What is required is that each flute shall have exactly the same taper, just enough clearance so that it will cut freely, and not enough to needlessly weaken the cutting edge.

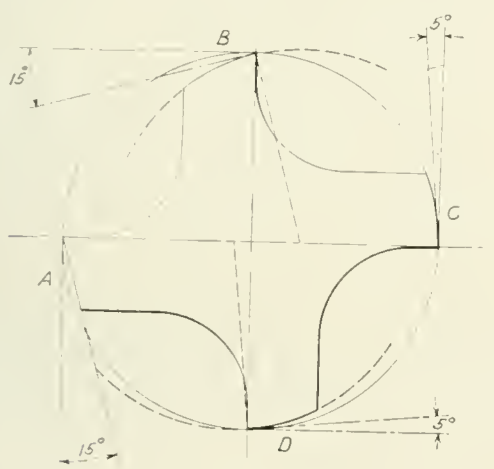


Fig. 1—Correct and Incorrect Tap Clearance

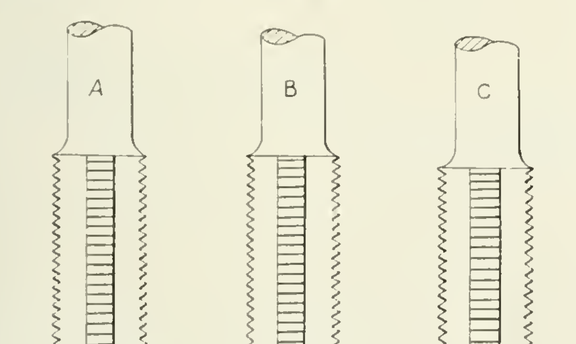


Fig. 2—A Uniform Flute Taper is Necessary

Prior to the advent of tap grinding machinery nearly all taps were ground by hand with a resultant lack of uniformity in taper and clearance. The accompanying diagram, Fig. 1, shows a section of a four-flute tap with each flute ground differently in the matter of clearance or backing off. The flute *A*, at the left, is ground with a straight line clearance just sufficient to have the heel of the flute actually clear and not drag. This calls for an angle of 15 deg., as indicated, and results in a weak cutting edge, but the strongest possible with a straight line clearance at the heel.

The flute *B*, at the top, shows a 15-deg. convex clearance. A glance shows this to be excessive. Flute *C*, at the right, shows a straight line clearance of five degrees, and nearly half of the flute at the back is not cleared at all, leaving the tap to ride on that portion and keep the front of the flute from cutting. Flute *D*, at the bottom, shows a perfect grind for ordinary work. It is a five-degree convex clearance and shows that with this small but sufficient clearance angle at the cutting edge, the back is perfectly cleared.

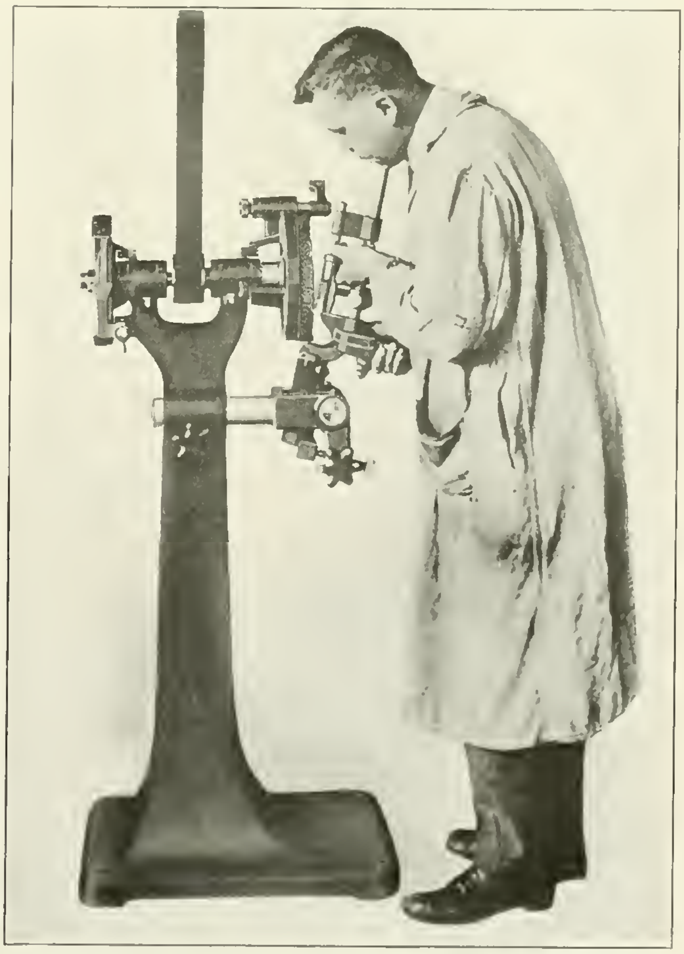


Fig. 3—No. 2 Grand Rapids Tap Grinding Machine

In addition to the correct clearance of taps a uniform angle of taper for all flutes is necessary. The results of different tapers obtained by hand grinding are indicated in Fig. 2. Even a slight variation from the uniform taper angle means power wasted and taps broken. As the blunt angle flute strikes the side of a drilled hole, it throws the cutting end of the tap off center and imparts to it a wabbling motion. This means a tapped hole that is oversized, allowing the screw to fit loosely. Tap *A* is correctly ground and will tap a hole true to size, properly located and with smooth, accurately shaped threads. Tap *B* is ground with one flute at a more blunt angle than the other. This blunt flute is shown just as it strikes the drilled hole. Tap *C* shows a similar tap after it has been crowded over. The condition developed is readily seen.

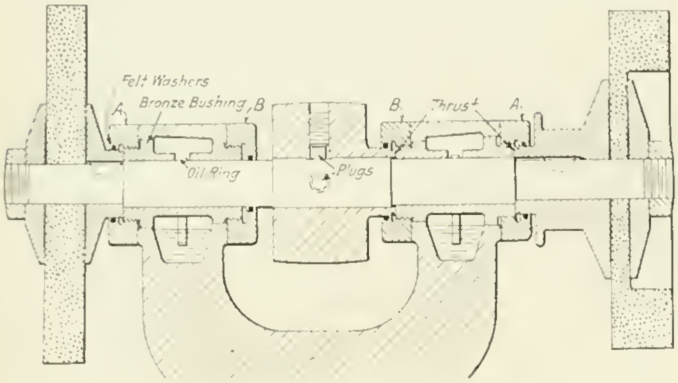


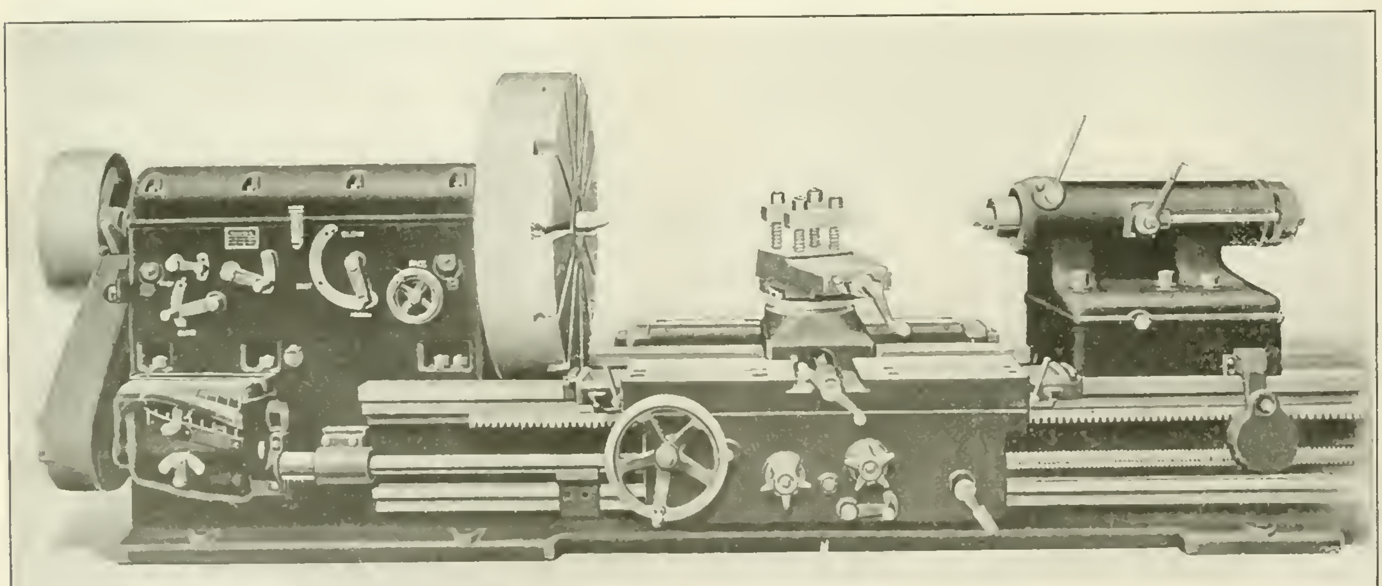
Fig. 4—General Arrangement of Spindle and Bearings

In the interest of longer life for taps and more correct work with less power consumption and fewer broken taps, the Grand Rapids Grinding Machine Company, Grand Rapids, Mich., has developed a line of machines for grinding taps. These machines are made in four styles for grinding all kinds of taps except possibly certain kinds of stay bolt taps. The No. 2, illustrated in Fig. 3, has a capacity to grind from ⅜-in. to 3-in. taps. The operator has the machine set for the proper taper and is shown grinding the tap flutes. By means of this machine the proper clearance, in the form of an arc of a circle, can be ground on any standard tap.

As with any grinding machine the spindle and spindle bearings are important, and their general arrangement on the Grand Rapids tap grinder is shown in Fig. 4. The spindles are of high carbon heat treated steel and run in dustproof phosphor bronze bearings with oil-tight adjusting collars, which prevent oil leakage. The machines are of rigid construction, being both simple to understand and easy to operate.

Nine Speed Geared Head Engine Lathe

To meet modern requirements, a new, all-geared lathe head has been designed by the Betts Machine Company, Rochester, N. Y., and applied to the company's full line of heavy duty engine lathes, ranging from a swing of 32 in. to 48 in. The new headstock is of the all-geared, enclosed type, operated by a powerful expanding ring friction clutch upon which the driving pulley is mounted. The clutch is reach of the operator. All speed changes are in geometrical progression and are obtained through hardened steel sliding gears and positive clutches running in oil. The edges of the gear teeth are rounded to allow for quick and easy engagement. There are 12 gears, including the face plate and pinion gear in the headstock. All back gear and triple gear speeds drive through the face plate gear, the driving pinion



Betts-Bridgeford High Power Engine Lathe with All Geared Head

operated from the apron and the same movement which disengages the clutch, automatically applies the friction brake, thereby stopping the machine with no loss of time.

Nine spindle speeds including three direct, three back gear and three triple gear speeds, are obtainable quickly and are controlled by three levers located on the headstock within easy of which can be disengaged when using direct spindle speeds. An interlocking device is provided so that no two speeds can be engaged at the same time.

All shafts and gears are located in the lower half or base of the headstock and not in the cover, which allows easy access to all of the parts, it being necessary only to remove the

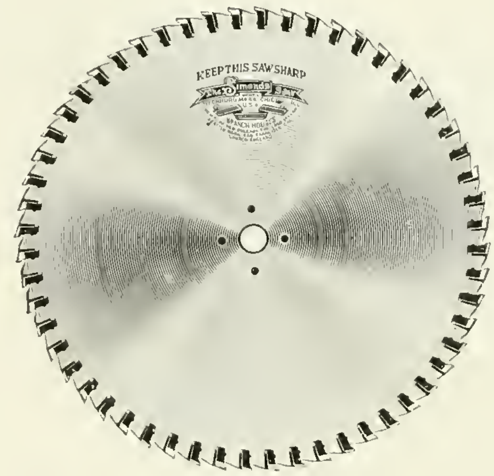
cover. All the shaft bearings are bronze bushed and lubrication is obtained by a pump located in the headstock and distributing oil to all of the bearings. This reduces the possibility of any bearing running dry as long as the oil is maintained at the designated height. When desired the lathe can be arranged for motor drive and in this case, the motor is mounted on top of the headstock cover and directly connected through gears to the main driving shaft.

Saw With Inserted High Speed Steel Teeth

A LINE of metal cutting saws with inserted high speed steel teeth has been placed on the market by the Simonds Manufacturing Company, Fitchburg, Mass. Among the advantages claimed for this saw may be mentioned a reduction in wear on the saw blade and the fact that when the teeth wear down they may be replaced by new ones, the diameter of the blade not being changed. Moreover, due to the inserted teeth of high speed steel, it is possible to make the body of a less expensive steel, with a resultant saving in cost.

Cold cutting saws are used in many railway shops, not only in the blacksmith shop for cutting up bar stock of all kinds, but in the machine shop for cutting out the fork ends of motion work and main rod straps. For these purposes high speed saws give a large production.

Simonds saws are now made in sizes as small as 10 in. in diameter. Up to 22 in. in diameter they can be made to cut a remarkably thin kerf, only 3/16 in. wide. Wider saws of this type are made in diameters up to 64 in.



Simonds High Speed Steel Saw

Electrically Driven and Controlled Planer

THERE is an increasing tendency in modern machine design towards electrical control and the resultant advantages in greater flexibility and ease of operation are most important. An example of electrical control in planer construction is afforded by the Hiloplane, manufactured by John Stirk & Sons, Ltd., Halifax, England, which company is represented in New York by Alfred Herbert, Ltd. A general view of the planer is shown, and among the interesting features may be mentioned a reversing motor drive by means of a special generator set, magnetic fields and the simplicity of setting the table stroke on a graduated dial, no table dog being employed for this purpose. An additional advantage is the possibility of cross planing.

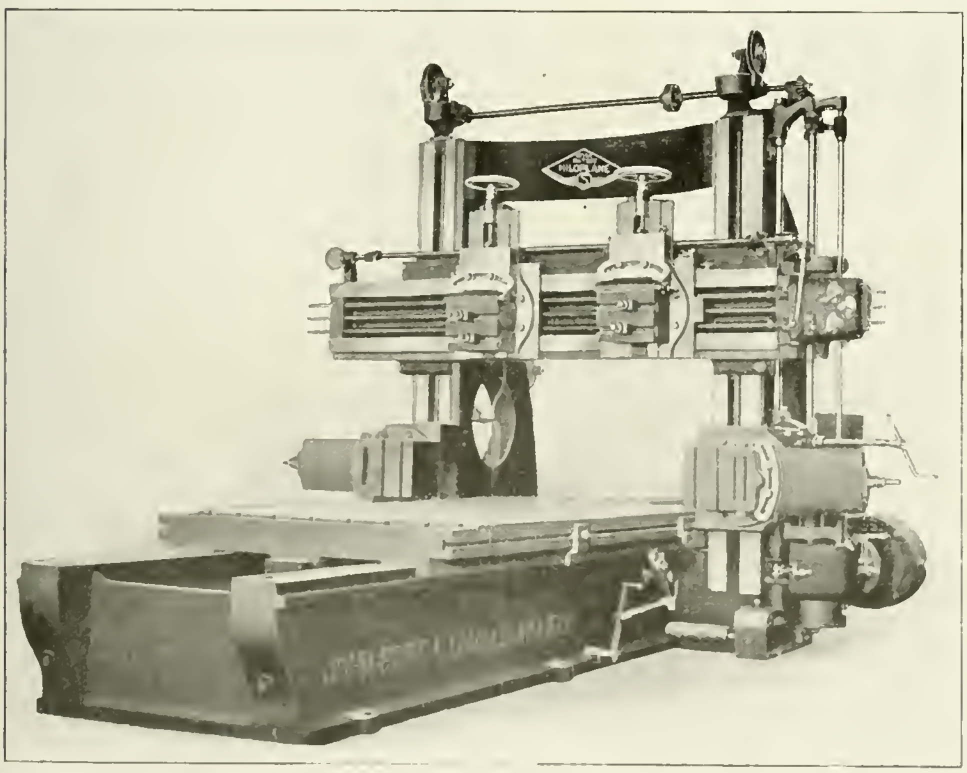


Fig. 1—Hiloplane Electrically Controlled Planer

It is possible to obtain high speeds with the electrically controlled planer, and on the other hand low speeds are available for special work. Particular attention is called to the magnetic feeds. A special motor generator set is used to supply current to the d. c. driving motor, and the latter is controlled by varying the field resistances of the former. The fields are excited independently and any variation in resistance changes the voltage with a corresponding change in armature speed. It is thus possible to obtain an infinite variety of speeds from a given normal speed down to zero. In practice the actual motor speed is seldom reduced more than 25 per cent on account of reduced torque. By adjusting the resistances in the fields, the upper limit of the reversing motor speed is usually increased, and any one of a large range of speeds can be obtained with the utmost ease. As previously stated, this wide range of speeds, taken with the sturdy construction of the planer,

makes the machine capable of maintaining the maximum speeds possible for ordinary duty on mild steel and also for extra heavy cutting at low and medium speeds on hard metal. Variations are made by the finest steps, and cutting speeds and return speeds are independently variable. A patent accelerating device is provided, by which the cutting speed may

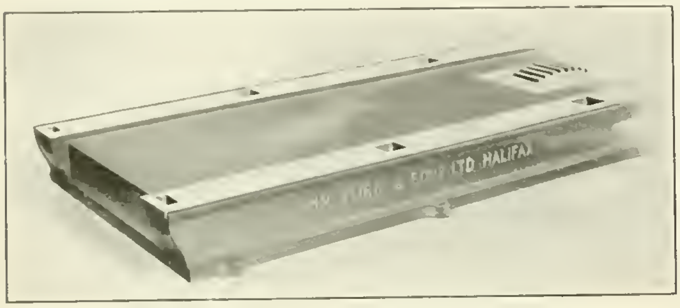


Fig. 2—Box Section Bed With Continuous Top Plate

be increased after the tool has entered the metal, or between surfaces. In this way gaps between surfaces may be quickly bridged which is an important advantage and time saver both in cases where the gap is between different pieces set up on the planer bed, and between two surfaces on the same piece.

A wide range of feeds is obtained by the magnetic feed control fitted to both the cross slide and vertical heads. By means of this arrangement variable and reversing self-acting

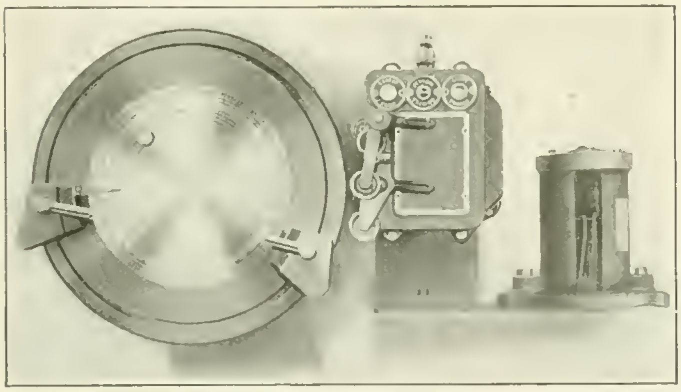


Fig. 3—Table Control Mechanism

feeds are obtained in horizontal, vertical and angular directions. Special provision is made for broad finishing cuts. The feed obtained depends upon the position of the handle in the horizontal slot shown in Fig. 4. A small separate feed motor shown in Fig. 4, is used for quick power traverse of the heads, which is obtainable in all directions. This also makes it possible to perform cross planing jobs, a valuable feature for short bosses on large pieces because it avoids an additional set up of the work.

The table control mechanism, illustrated in Fig. 3, is simple and the length of the table stroke is obtained by fitting stops on the graduated dial, instead of setting table dogs. The reversal of stroke is obtained by the action of the stop on a reversing switch. By means of this electrical control and the absence of table dogs, it is possible to obtain a stroke of 4 in. The table may be started or stopped from either side of the

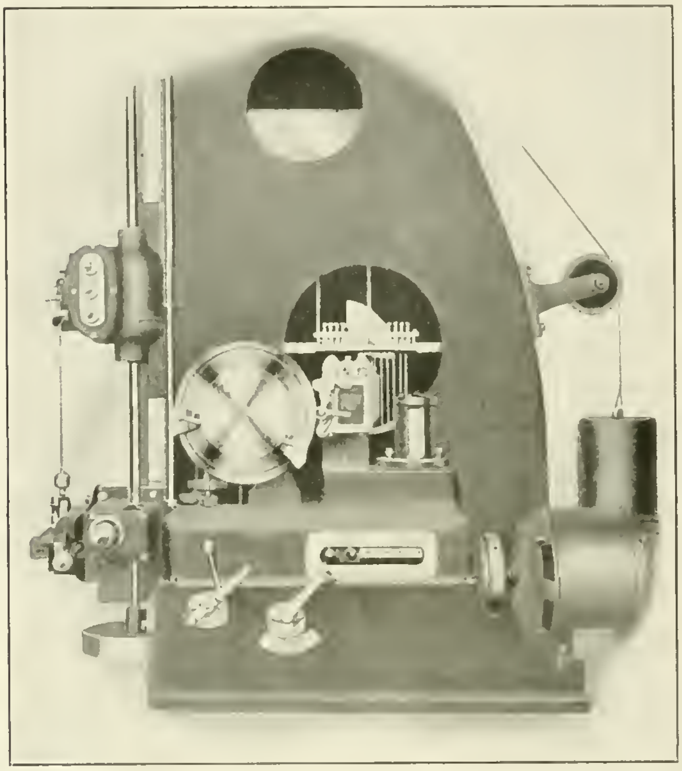


Fig. 4—View Showing the Magnetic Feed Control

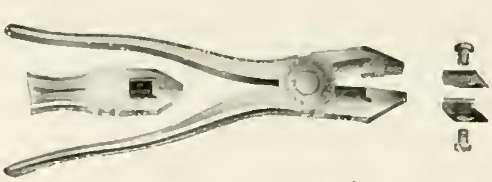
bed, and a hanging switch is provided for convenience in setting up. A safety switch arrangement also prevents the table from running off the tracks.

To insure safety at high speeds, the pinions are forged solid with their shafts. The motor generator set is not mounted on the machine but in a convenient position apart, thereby eliminating vibration. The control of the table is by a switch button for starting and stopping. Due to its flexibility and ease of control, this machine is adaptable to a wide variety of planing operations in machine shops where high production and accurate work are the ends in view.

Side Cutting Pliers With Renewable Jaws

PROBABLY the weakest point in the pliers ordinarily used by electricians and mechanics has been the jaws, and to overcome this weakness the Neverslip Works, New Brunswick, N. J., has developed a type of pliers with renewable steel jaws. This important feature makes it unnecessary to throw away a pair of pliers in case the jaws become broken or worn out. It is only necessary to remove the worn blades and insert new ones, which is a quick, inexpensive operation.

Another feature of the side cutting pliers, illustrated, is the fact that the method of making them in two parts permits the manufacturer to select the best possible steel for each purpose. The jaw blades are made of high grade crucible steel, insuring both tough and sharp jaws. The handles



Pliers With Renewable Jaws

are made of drop-forged steel, which reduces the chances of breaking under ordinary usage to a minimum.

Production Automatic Milling Machine

An automatic milling machine intended for the manufacture of duplicate parts in large quantities has been placed on the market recently by the Brown & Sharpe Manufacturing Company, Providence, R. I. It is essentially a manufacturing machine, known as the No. 21 automatic milling machine, Fig. 1. It has structural characteristics common to the other styles of plain milling machine of the column and knee type, but in the application of automatic control to that of a plain milling machine, many new and important features were developed.

By means of adjustable dogs on the front of the table, the control of the spindle and table is entirely automatic. These movements include a variable feed, constant fast travel and a stop for the table; start and stop, and right and left hand rotation for the spindle. The table and spindle may be operated independently of each other, and these movements may or may not be intermittent in either or both directions and may take place one or more times. The spindle may be

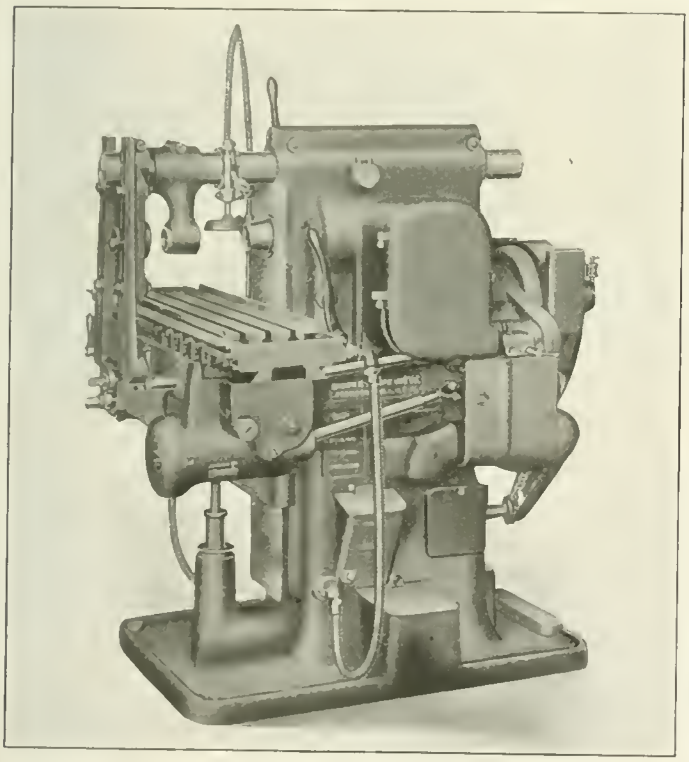


Fig. 1—Brown & Sharpe No. 21 Automatic Milling Machine

stopped upon the return travel of the table, thus eliminating the possibilities of marring the work, and the spindle reverse allows the use of two sets of cutters, with teeth facing in opposite directions, so that one set may be in operation for one direction of table travel and the other set for the opposite direction of table travel. A constant fast travel and a slow, variable feed in both directions are automatically controlled by the table dogs.

There are four different style dogs necessary to operate all the automatic movements of the machine, but for all ordinary milling operations, two or three of the styles are usually sufficient. A long dog *A*, Fig. 2, used at *A* or *B* controls the reversing of the table. This same dog also stops the table, if it is so desired, and the table stop lever is set. Dog *C* controls the constant fast travel, and dogs *D*1 and *D*2 control the variable slow feed, it being possible to set these dogs to operate in either direction. The variable slow feed dogs are trip dogs made changeable to operate, as shown at *D*1, when the direction of the table travel is to the right, and as shown at *D*2 when the direction of the table travel is to the left.

The table always moves at its constant fast travel when reversed, and when the machine is set for reversing the spindle, the spindle is reversed when the table is reversed. When the machine is set for stopping the spindle, the spindle stops when the table is reversed and starts with the fine variable table feed. No extra tripping dogs are required for either reversing or stopping.

Continuous milling operations may be performed by employing two *A* dogs and two *D* dogs, and for intermittent milling operations, dogs *A* and *B* and dogs *C* and *D* are employed, the number of pairs of *C* and *D* dogs depending upon the number of pieces of work on the table.

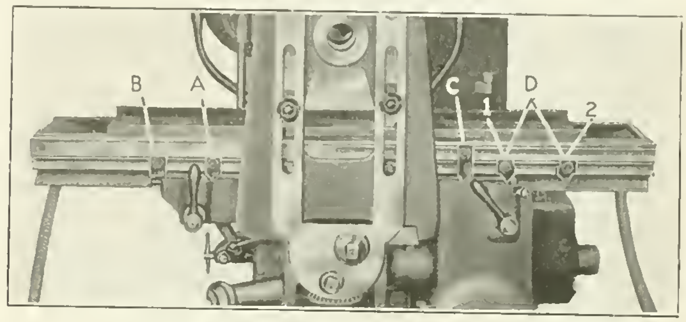


Fig. 2—Automatic Spindle and Table Control is Secured by Adjustable Dogs

Although the automatic control of the spindle and table is by means of table dogs, the same results may be attained by hand, employing the two controlling levers located on the front of the saddle. Occasionally the loading time of a piece exceeds the cutting time, and the table is set to stop for the safety of the operator. Under these circumstances the machine is semi-automatic in operation, and the hand control levers are employed in place of the dogs.

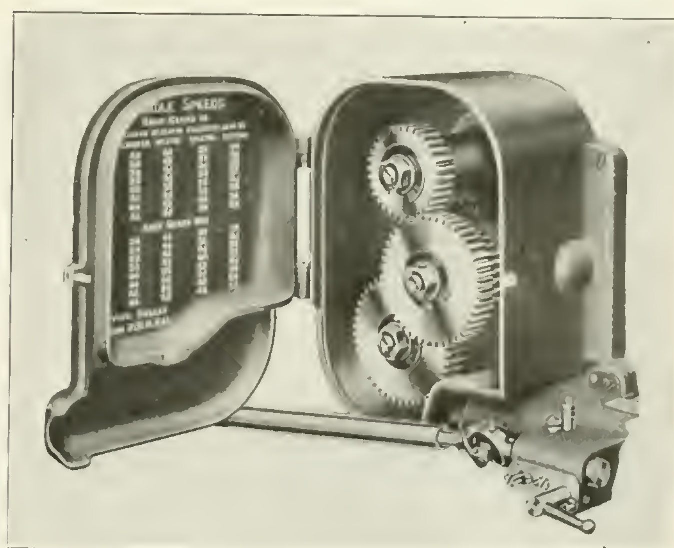


Fig. 3—Spindle Speed Change Gear Case

Manipulation of the controlling levers is extremely simple, and the ease and rapidity with which they may be operated is in some cases faster than when it is fully automatically operated. By means of the hand-control levers, the machine may be operated as a plain milling machine.

The constant speed type of drive permits the machine to be driven by a belt directly from the main shaft to the single-

driving pulley. Mounted upon the drive shaft are the friction clutches for starting, stopping and reversing the spindle automatically, and this arrangement relieves the spindle of all unnecessary weight. Power is transmitted from the shaft to the spindle through a series of spiral bevel gears, which furnishes a smooth and powerful drive.

Another advantage of the constant speed type of drive is the complete separation of the spindle speeds and the table feeds, permitting any combination of the two within the capacity of the machine. Variations of the spindle speeds are obtained through change gears, giving 16 changes of speeds in geometrical progression from 28 to 695 r.p.m. in either direction. The table feeds are positive and are entirely independent of the spindle speeds. There are 12 changes, ranging from 1.57 in. to 18.38 in. per minute. This provides a range of 0.002 in. to 0.050 in. per revolution of the spindle for small mills and 0.026 in. to 0.656 in. per revolution of the spindle for large mills. Both sets of change gears are contained within heavy cast iron cases and are made readily accessible by doors, upon which are cast tables of the proper gears for the various spindle speeds and table feeds. The spindle speed change gear case is shown in Fig. 3.

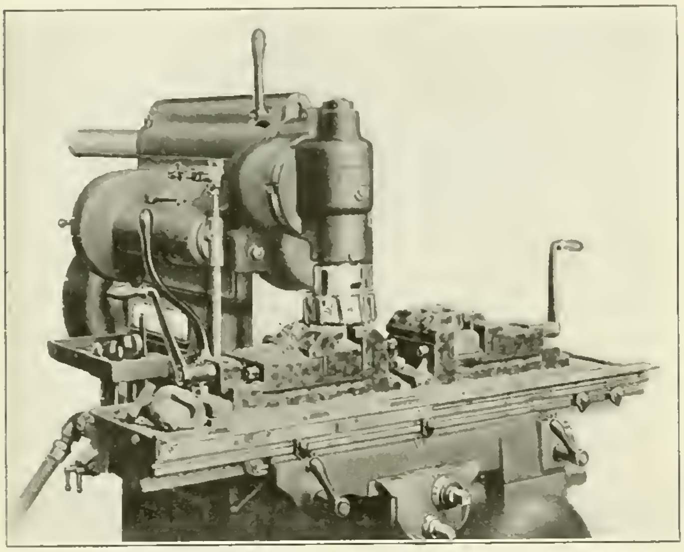


Fig. 4—View Showing Adaptability for a Vertical Milling Attachment

When motor drive is desired, the motor is placed at the rear of the machine where it is completely out of the way and does not increase the floor space occupied. In this case the motor is mounted on a heavy bracket firmly bolted to pads provided on the base of the machine. A belt transmits the power from the motor to the single driving pulley and a cast iron guard protects these parts from dust and grit and the operator from injury.

The front end of the spindle is tapered, hardened and ground and has a recess to receive a cutter driver and clutch on arbors and collets. The reverse gearing and cams, actuated by the table dogs are assembled as a unit in an oil tight case and this unit of mechanism is automatically lubricated and protected by a safety friction coupling set to slip at a predetermined load, thus guarding against possible damage. The other unit of mechanism that responds to the action of the table dogs is that which controls the constant fast travel of the table and the variable table feeds. This unit is provided throughout with ball bearings and is also automatically lubricated, being contained within an oil tight case. The adaptability of the machine for use with a vertical milling attachment is illustrated in Fig. 4.

The automatic lubrication of all rotating parts within the frame of the machine is another important feature. Filtered oil is pumped to a reservoir cast in the top of the frame and by means of pipes and a gravity system oil is constantly distributed to the various bearings. For manufacturing purposes an abundant supply of cutter lubricant is pumped from a large tank located within the base of the machine.

Realizing the importance of a rigid construction in a high productive machine of this type, the designers have embraced features adapted to these conditions. The column, knee, and table, are provided with internal bracing and reinforcing ribs. The wearing surfaces of the table and bearings throughout the machine are of such proportions as to provide for the severe service to which a strictly manufacturing machine is subjected.

The machine has a longitudinal table feed of 22 in. and transverse adjustment of 6½ in. with a vertical adjustment of 14½ in. The spindle is provided with a No. 10 taper hole. The speed of the drive shaft is 300 r.p.m. and the power consumption is 5 hp.

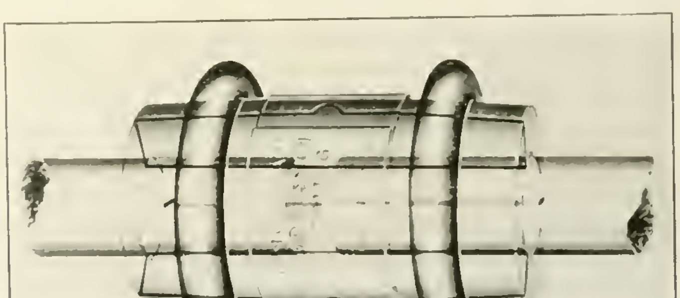
Compression Coupling Saves Time and Labor

A MATERIAL saving in the time and labor heretofore required for connecting line shafting can be effected by the use of a new compression coupling manufactured by the Cincinnati Ball Crank Company, Cincinnati, Ohio. The outstanding features of the coupling are simplicity, ease of application and adaptability to all standard shafting.

In construction, the coupling shows a radical departure from the old type of flange and bolt connection. It consists of only five pieces: three jaws, and two clamping rings. The jaws of the coupling are set in position about the shaft, and held in place by the longitudinal grooves and notches that lock them together. The forged clamping rings are pushed on over the tapering ends of the jaws, and hammered tight.

A hammer is the only tool required to apply the coupling, no dismantling or machining of the shaft sections being needed. The only requirement is sufficient clearance between the sections to allow the clamping rings to pass.

The coupling grips the joined sections of the shaft, holding them in alinement. The round, machined sections of the tapered end of the coupling jaws form lines of contact for each ring, and once driven into place, it is practically impossible for the coupling to become loose. Compression couplings of this type have been in use three years with no adjustment since their installation.

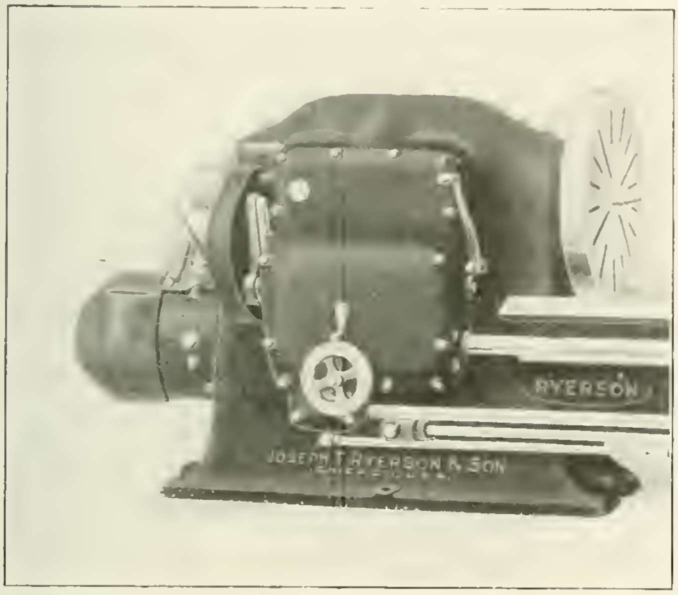


Cincinnati Compression Coupling

The assembled coupling forms a clean, compact shaft joint with no projections on its outer surface to catch a workman's clothing, thus insuring safety for employes. When used as a reducing coupling, the only additional parts needed are three strips of cold rolled steel to fit between the smaller shaft and the inside of the coupling jaws. The couplings are made in sizes to couple shafting from 15/16 in. to 3 in. in diameter.

High Power Selective Head Engine Lathe

A WELL balanced line of engine lathes, designed for quantity production as well as general machine shop work, has been placed on the market recently by Joseph T. Ryerson & Son, Chicago. The machines are made in five different sizes, including 15-in., 18-in., 22-in., 27-in.



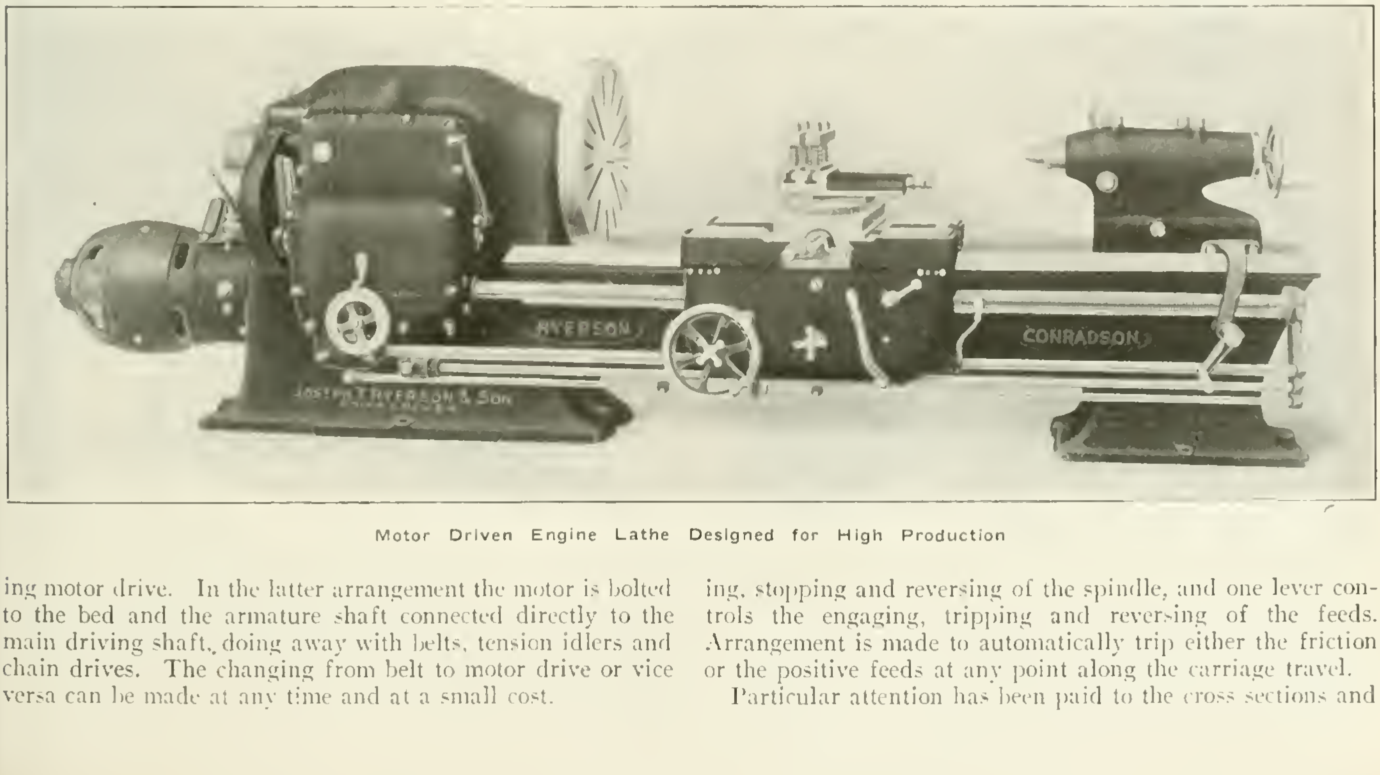
Single Pulley Drive Arrangement

and 33-in. swing, with any length of bed. A notable feature in the design is the method of driving. With very slight changes the lathe can be adapted to constant speed single pulley drive, with or without spindle reversing attachment, or direct reversing motor drive. In the latter arrangement the motor is bolted to the bed and the armature shaft connected directly to the main driving shaft, doing away with belts, tension idlers and chain drives. The changing from belt to motor drive or vice versa can be made at any time and at a small cost.

For convenience in operation and cutting down all possible lost motion, the lathe controls have been centralized on the apron, and from one position the operator may start, stop and reverse the spindle instantly, engage, reverse or trip the feed, as well as traverse the carriage and cross slide. The 12 spindle speeds are changed by means of two levers on the headstock, one of which controls the various sets of change gears and the other the back gears. The action of both levers is practically instantaneous, and all changes may be made while the lathe is in operation. The handwheel, shown on the headstock, can be turned to any desired feed marked on its circumference, automatically selecting the feed indicated.

To secure greater rigidity, the lathe headstock has been cast integral with the bed, the latter serving as a container for oil, in which part of the gears run. All gears are lubricated by the splash oil system. The spindle is proportionately large in diameter to eliminate vibration as far as possible, and a ball thrust bearing takes up the heavy working strains. Power is transmitted to the spindle through a phosphor-bronze driving pinion and a large herringbone gear. This type of drive reduces back lash to a minimum and gives a steady driving torque. The back gears, as well as all change gears, are permanently in mesh, and all changes can be performed with rapidity and without danger of engaging more than one set of gears at a time.

The spindle drives a large spur gear connected to the feed-reversing mechanism, which is operated from the apron. Twenty-eight feeds are obtained by two sets of geared cones, which in turn are actuated by a handwheel and lever on the headstock. The carriage longitudinal and cross feeds are effected by independent sets of worm gears which are engaged by large friction cones. The positive feeds consist of a large split nut made of phosphor-bronze and an effective safety device is provided. One lever on the apron controls the starting, stopping and reversing of the spindle, and one lever controls the engaging, tripping and reversing of the feeds. Arrangement is made to automatically trip either the friction or the positive feeds at any point along the carriage travel.



Motor Driven Engine Lathe Designed for High Production

Particular attention has been paid to the cross sections and

proportions of the ways of the bed. The guiding surface of the vees is inclined at 15 deg. to the perpendicular and the supporting surface at 15 deg. to the horizontal. The vertical depth is at least twice as great as in the usual construction and, due to the broad supporting surfaces, the wear on the carriage and ways is reduced to a minimum. The usual extra attachments can be supplied with the new Ryerson-Conradson lathe, if required.

Boring Mill for Heavy Accurate Work

ONE of the most desirable characteristics of a machine tool designed for railway shop work is the ability to stand up under heavy roughing cuts in tough steels, and possibly in the very next operation produce some machine part to a fine limit of tolerance. It would be difficult to devise a more strenuous test of a machine tool's ability to render consistent service on all classes of work within its range and yet, the above test is one which must be met every day in railway machine shop work owing to the widely divergent character of the machine operations to be performed.

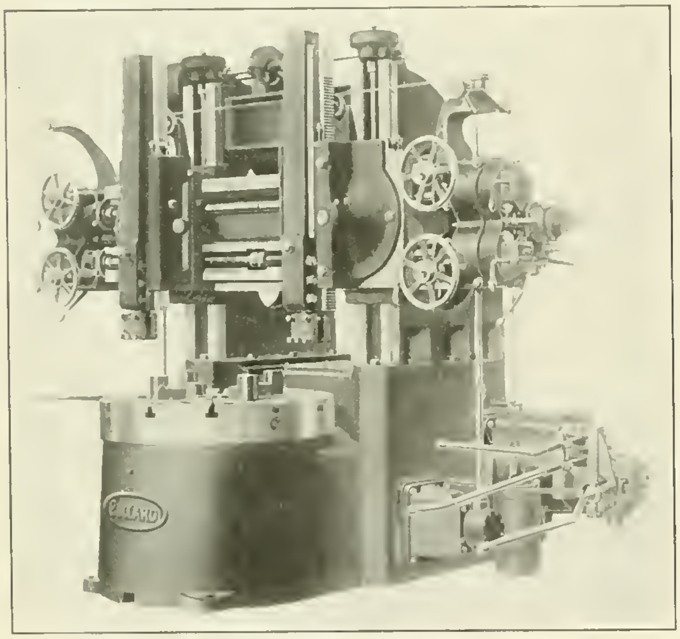


Fig. 1—Bullard 44-In. Maxi-Mill

Equal facility in taking cuts up to its maximum capacity or doing work requiring a high degree of accuracy is possessed by the 44-in. Maxi-Mill illustrated in Fig. 1. This new machine, made by the Bullard Machine Tool Company,

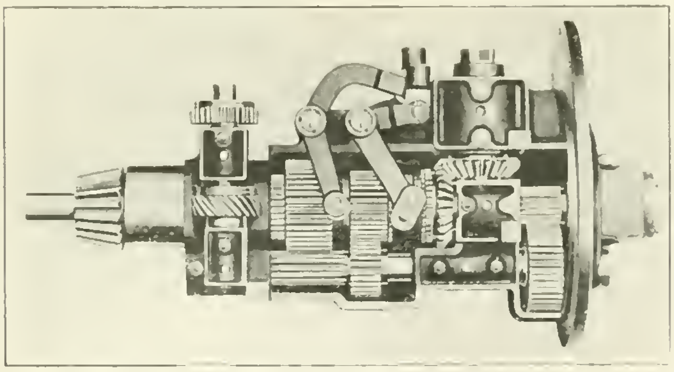


Fig. 2—Improved Secondary Speed Change Case

Bridgeport, Conn., is the smallest one of a line of boring mills embodying the principles of unit construction, centralized control, continuous flow lubrication, and cutting lubricant system previously described in the June, 1918, *Railway Mechanical Engineer.*

Certain improvements have been made in the secondary speed change case, shown in Fig. 2, to secure a power unit of maximum strength and durability.

The most important improvement in the new design is the use of two driving gears, rigidly keyed to the drive shaft instead of sliding upon it. The clutch gears have internal teeth meshing with spur gears and form a positive lock. The gears are all of relatively greater size and so guided upon their mating gears as not to produce braking shocks when shifted.

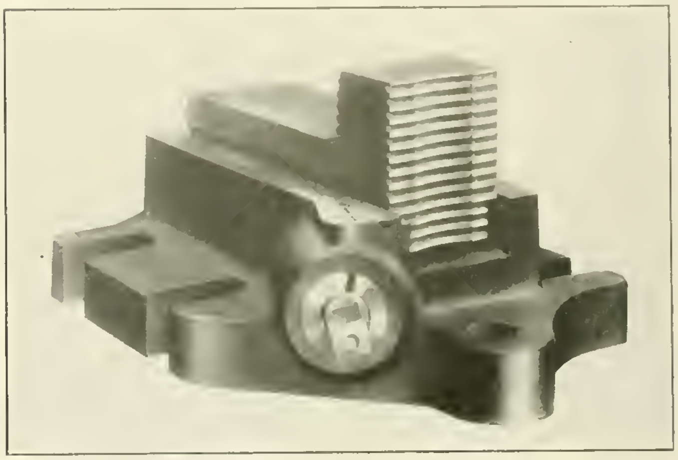


Fig 3—Bullard Independent Face Plate Jaw

A plain table with radial T-slots, three-jaw combination chuck, or four-jaw independent chuck, may be provided with the 44-in. Maxi-Mill. Both the three and four-jaw chucks are powerful and have been developed to meet the exacting requirements of the vertical turret lathe. The chuck bodies are heavily proportioned to avoid distortion and operating parts are made of selected materials best suited to the service required. The sliding jaws are of forged steel accurately fitted to the chuck body and special arrangement is made to prevent foreign matter getting into the operating mechanism, which is packed with non-fluid oil and graphite. The top jaws are adjustable, mounted on sliding members and may be reversed or removed readily.

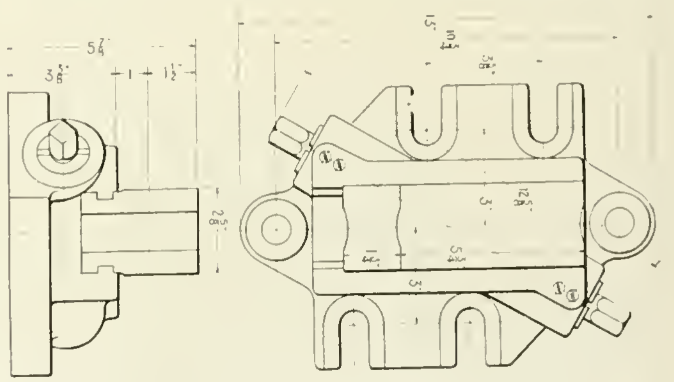


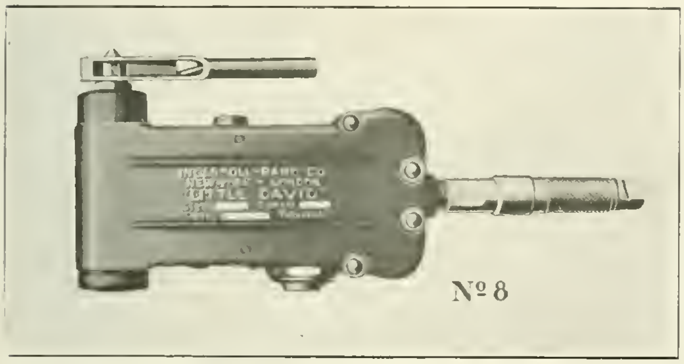
Fig. 4—General Dimensions of Independent Face Plate Jaw

In case odd shaped pieces are to be machined, or work that is off center, the best arrangement is to use independent face plate jaws in conjunction with a plain table. These jaws, one of which is illustrated in Figs. 3 and 4, are both convenient to operate and great time savers. They are not limited to machines having the Bullard standard arrangement of T-slots.

The bodies of the independent face plate jaws are made of drop-forged steel. The top jaw, Fig. 3, is made of special steel, and is not liable to distortion or fracture under severe service. The actuating screw being placed at an angle with the jaw gives a powerful differential movement, which resists any backward strain or tendency to loosen the jaw when under cut. This arrangement also permits the operator to use a wrench on either end. The jaws are securely held to the slots of the table by two bolts and are reversible.

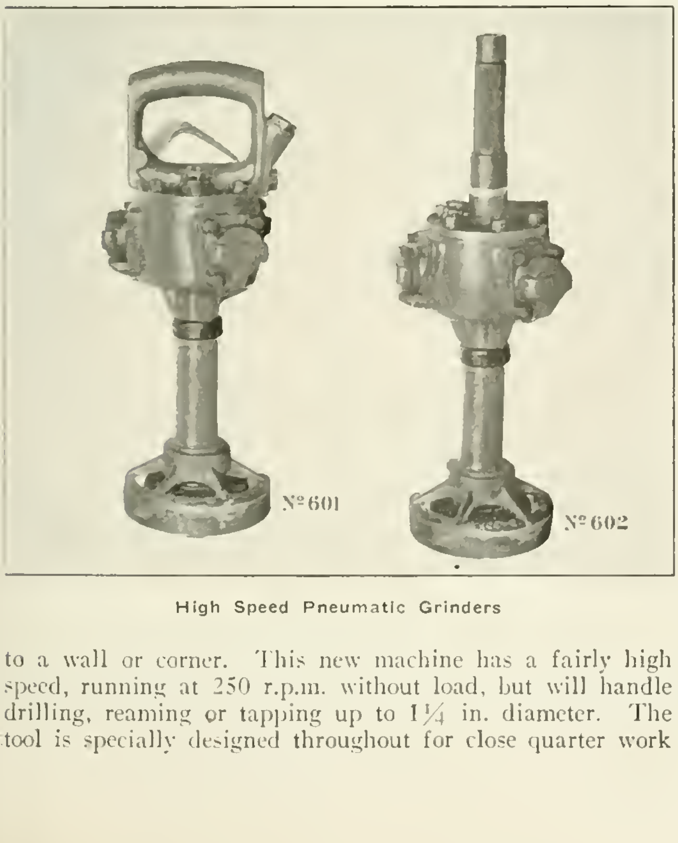
Small Portable Pneumatic Tools

SEVERAL new sizes of small portable tools have been added recently to the line of "Little David" pneumatic tools manufactured by the Ingersoll-Rand Company, New York. The new tools, as shown in the illustrations, include a No. 8 small close quarter drill, two small high speed pneumatic grinders, No. 601 and No. 602, and two lightweight drills, No. 6 and No. 600. It is poor economy to use heavy pneumatic tools for light work and the lightweight, high speed machines described in this article are well adapted to railway shop work often done with heavier equipment.



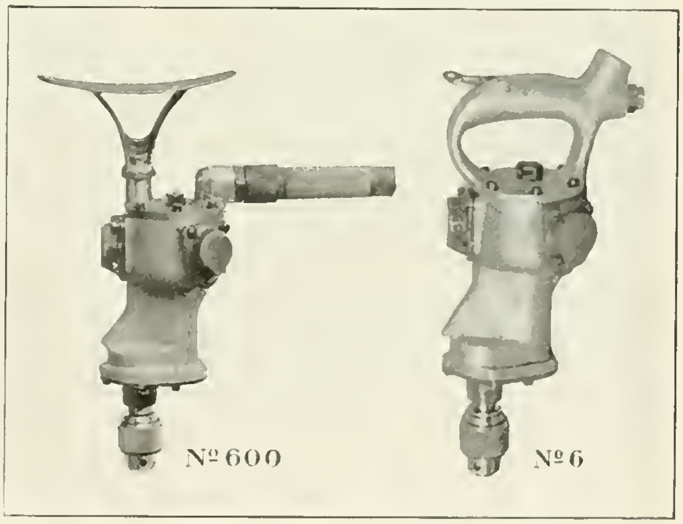
Ingersoll-Rand Close Quarter Drill

The close quarter drill is for use in a limited space close to a wall or corner. This new machine has a fairly high speed, running at 250 r.p.m. without load, but will handle drilling, reaming or tapping up to 1¼ in. diameter. The tool is specially designed throughout for close quarter work and has several unique features. The spindle which turns the drill, reamer or tap, is operated by three rocking levers connected directly to the pistons through connecting rods. The motor is of the three cylinder type with pistons acting at right angles to the levers. A steady, continuous movement of the spindle is obtained, as one ratchet pawl is always in contact with a tooth of the spindle. The construction is simple and sturdy, with the least number of parts consistent with approved design.



High Speed Pneumatic Grinders

The No. 601 and No. 602 grinders run with a free speed of 4200 r.p.m. and are suitable for grinding, buffing or polishing work of a varied nature. Each machine has the same type of motor, but is equipped with a different throttle and handle. The No. 601 has the closed type of inside trigger handle, while the No. 602 is fitted with the rolling type of throttle handle. A special feature of these tools is the three cylinder motor (entirely different from that of the No. 8 drill, described above) which runs constantly in a bath of oil, insuring lubrication of all the parts. Lack of proper oiling has been one of the reasons for grinder troubles in the past. The valve is made integral with the crankshaft, simplifying the design, and the piston and connecting rods also are of special construction. Ball and roller bearings are used throughout. The removal of a few screws enables the handle to be lifted off and exposes the entire mechanism to view, making inspection of the parts easy.



Light Weight Pneumatic Drills

The No. 6 and No. 600 drills meet the demand for light air tools required to drill small holes without breaking the drills. They will handle twist drills from the smallest size up to ⅜ in. diameter. The free speed at 90 lb. air pressure is about 2000 r.p.m. The two machines differ essentially in the handle construction, the motors being the same. The No. 6 has the pistol grip type of handle, while No. 600 is furnished with breast plate and rolling throttle handle. Aluminum, reinforced with steel bushings, is used wherever pos-

sible and results in a lightweight machine; the No. 6 weighing only 9 lb. The motor is a three cylinder type somewhat similar to that used in the grinders mentioned above. The cylinders are separate iron castings, easily accessible, renewable and interchangeable. A sensitive throttle control has been obtained, which with freedom from vibration makes the tool well adapted for drilling with small drills. The bearings are all either of the ball or roller type.

Vortex Paint Spraying Equipment

PAINTING with mechanical appliances for industrial buildings, tanks, and other large equipment has been a recognized method long enough to win a firm contingent of supporters and also to array an equally firm support behind the older process of hand painting. That the hand painter holds on can only be regarded as proof that the problem of mechanical painting is more difficult than imagined by many of those who have offered various shapes and forms of spraying devices.

Vortex Painter in Use On Metal Building

A few of the characteristic difficulties of paint spraying are (1) loss of paint, (2) scattering and splashing over surfaces not to be painted, (3) difficulty in the open air owing to wind interference, (4) pre-drying of the paint to a chalky consistency through evaporation of its volatile oils while in the air.

With these difficulties in mind, a paint spraying equipment has been perfected by the Vortex Manufacturing Company, Cleveland, Ohio, and placed on the market. The equipment includes a portable air compressor, paint tank and a nozzle. The Vortex nozzle has two openings, a central opening for paint and an annular opening around the center from which the air is discharged under a pressure approximating 60 lb. per sq. in. There are separate conduits for air and paint, terminating in a right angle on each side, which forms an axis for the nozzle and permits it to be operated at any desired angle.

The paint is driven from the central outlet under low velocity and is immediately picked up by the surrounding air jet and carried to the painted surface. The air jet is too powerful for the paint to penetrate and the loss from spattering is remarkably small, the whole tendency being to spread evenly rather than spatter.

It is claimed that the Vortex painter carries a greater volume of paint per minute, due to the fact that it is not finely sprayed but applied in a relatively heavy liquid jet; there is a better penetration of rough surfaces and a more efficient brushing action by the air jet which makes it possible to cover completely and smoothly with a single coat. Scaffolding can be very largely dispensed with by use of a 12-ft. arm, when desired. There is also the important advantage of having a powerful air jet for cleaning dirty surfaces and reaching crevices and out of the way corners.

Any fairly efficient jet system should have an advantage over brushing in the treatment of rough surfaces, such as rock faced masonry, rough lumber, etc., because perpendicular application of the paint is certain to penetrate voids better than brushing across the surface.

It is possible to paint 2,000 sq. ft. per hour or more on plain interior work with a Vortex painter where conditions are favorable and the operator experienced in his task. A striking demonstration of possibilities in outdoor work was the painting of a large storage tank on the roof of a building. This was given a single but sufficient protective coating of red in three and a half hours, although the tank had 3,500 sq. ft. of surface. It rose 18 ft. from the top of the tower on which it was located and no ladders or scaffolding were required.

Air Required to Operate Preheaters

THE following data are the result of recent tests made by the Metal & Thermit Corporation, New York, to determine the proper amount of air required for special thermit welding gasoline and compressed air preheaters. The practical minimum pressure for operating preheaters appears to be 25 lb. per sq. in. At this pressure a single burner preheater will require approximately 25 cu. ft. of free air per minute and a double burner preheater approximately 50 cu. ft. of free air per minute. For very large welds, where the walls of the molds are thick and the preheater gates longer than usual, a pressure of 40 lb. per sq. in. would be advisable, which would require approximately 35 cu. ft. of free air per minute for a single burner preheater and 70 cu. ft. of free air per minute for a double burner preheater.

In the case of large shops with a central air compressor plant, upon which demands are being made by many departments, the pressure quoted above should be maintained at the outlet to which the preheaters are attached. This is a very important point as, too often, the operator forgets that a considerable loss of pressure takes place in the pipe line.

Large Capacity Multiple Spindle Automatic

A MARKED advance in automatic screw machine design has been registered in the development of large capacity 3-in. and 4-in. multiple spindle automatic screw machines by the National-Acme Company, Cleveland, Ohio. These machines were evolved as a result of the demand for a larger unit of the National-Acme line, which previously only had a range up to 2¼ in. Two of these machines have been installed in a railroad shop and are very successfully working on side rod oil cups, ball joint rings for injector branch pipes, etc.

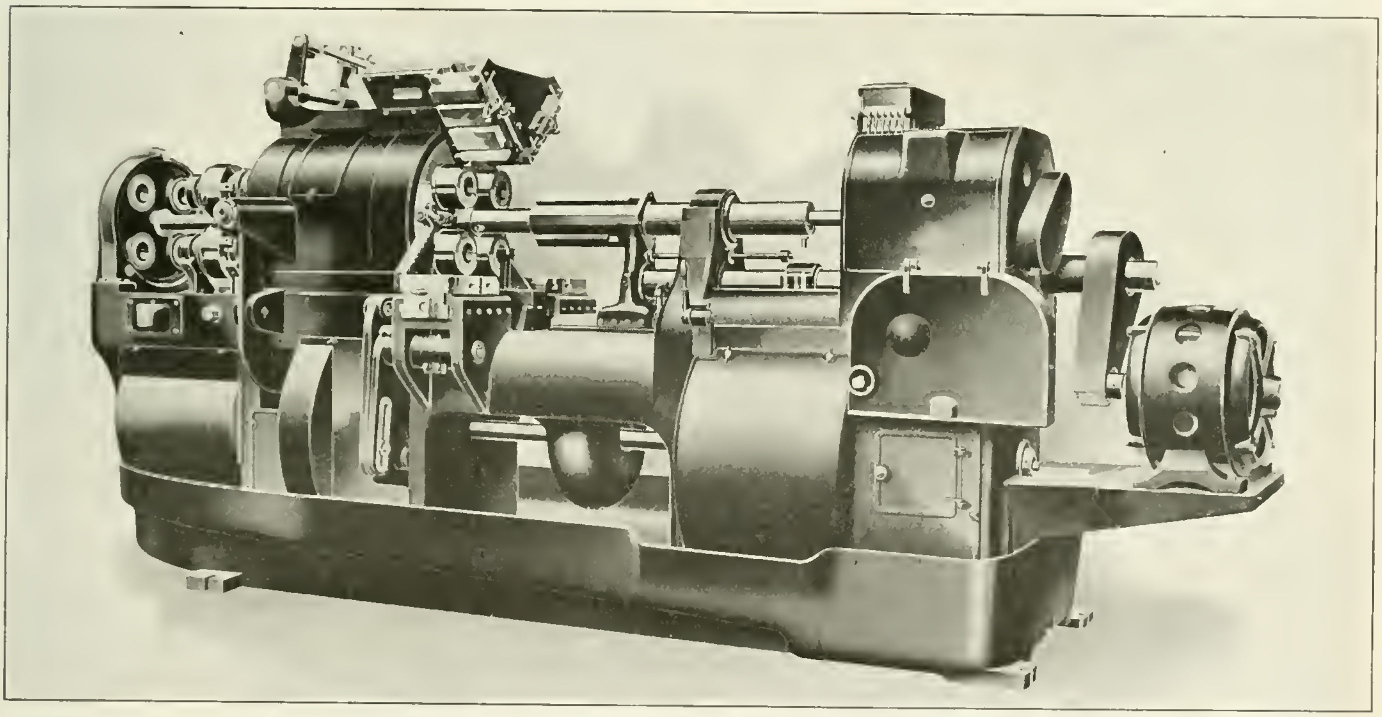
Many new features were incorporated, necessitated by the large capacity of the machines and to insure rigidity and accuracy under heavy cuts and feeds. Heavy and rigid design to cope with tough composition steels, maximum cutting feeds and speeds made possible by modern tool steel, precision and fast output were the goals. These combined with standardization of equipment, convenience in operation, safety devices, reduction in unit driving power and simplicity of design have been secured in this machine, still adhering to the principle of performing all screw machine operations in the time of the longest single cut. One notable departure has been made in the method of tooling, however, so that the 3-in. and 4-in. machines use right hand tools exclusively.

The design of the main tool slide or end tool turret provides the most rigid support for tools, as well as accessibility for setting up. It is a semi-steel casting in one piece, one end of which extends ahead of the four-faced turret proper and has its bearing in the center of the cylinder. The rear end is supported in a heavy bearing through an upright extension of the frame, which is cast integral with the bed itself. It is supported just back of the tools by an extension of the pusher rod which controls the feed of the tool carrier. This pusher is independent of the tool carrier proper, being connected to the carrier at the top by a pin, and at the bottom it travels on a wide-bearing plate mounted on the center of the frame. From the pusher rod is an extension with a roller for the lead cam. This extension is fastened to the pusher rod which is supported at a 45 degree angle with respect to the lead cam, and its movement is against a hardened steel plate screwed to the bed. The bearings receive no side thrust from the lead and take-back cams.

Because of this rigid system of supporting the tool carrier, side thrust is equalized so that heavy cuts and coarse feeds may be employed to the maximum capacity of the machine, and yet insure accuracy.

The stop-rod between the pusher and the carrier is the main stop for accurately regulating the length of the turret travel. This is controlled by nuts adjusted for different lead cams. Tool holders having wide bearings are fastened against four flat surfaces of the turret, and are supported directly underneath their cutting points with no overhang.

The forming and cut-off slide bearings are cast with the bed, and so designed as to support the forming tool its entire length, and directly underneath the cutting pressure. The connection between the forming and cut-off levers and their slides is through a 2½-in. hexagon shaft, assuring positive feed to the slides, without spring. The slides are adjusted vertically by taper gibs, and horizontally by straight gibs. The levers, controlling the feed of the cross slides, are provided with slots, making them easily adjustable and requiring only minimum change of cams for different feeds. With this adjustable arrangement, for forming and cut-off levers only three cams are required for all work within the capacity of the machines, two being ample for normal work and furnished with the machine.



Acme Multiple Spindle Automatic, 3-In. to 4-In. Capacity

A forming stop, consisting of a bracket mounted on the slide in connection with adjustable studs located between each of the four spindles, provides a separate adjustment for each, and is a further safeguard for uniformity of product.

To facilitate quick, accurate adjustment for the depth of cut for the forming and cut-off tools, screws are operated through the center of the slides independent of the tool holders.

The top slides are operated by two straight and interchangeable cams through rods and levers, arranged so that

both slides can be adjusted by manipulating one interchangeable cam on the main cam shaft. The lever shaft controlling the travel of both slides is hexagonal, thus obviating any chance of the loosening, common to key set shafts. The top slides accommodate the same holders and tools that are used on the forming and cut-off slides, and the method of adjusting the slides by gibs is the same.

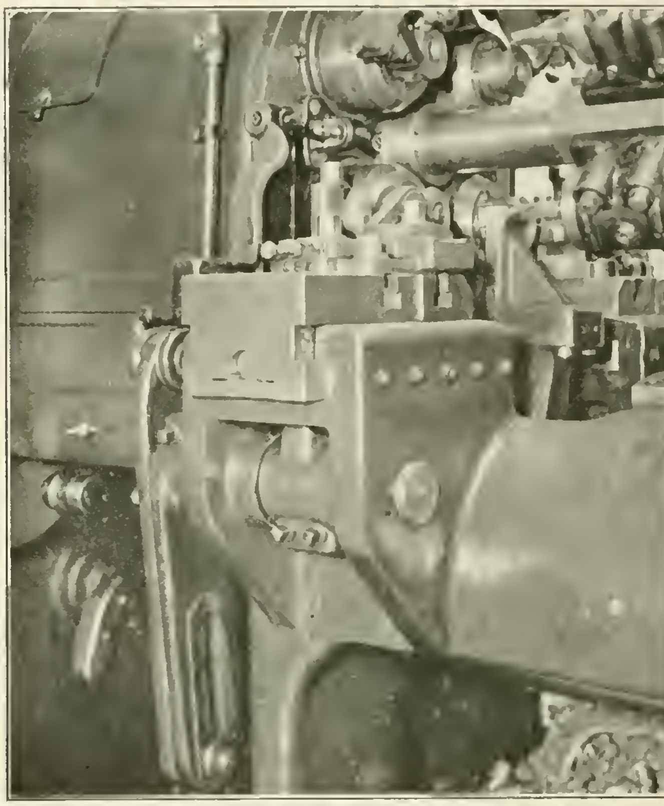
New features in the cylinder construction tend to minimize wear and provide easy adjustment. The cylinder casing has been made unusually strong, and in addition to being secured to the bed by heavy bolts, the casing is dovetailed to the bed. Two brass shoes are located independently on top of the cylinder casing for both front and rear bushings, and are adjusted by screws without any interference with the top slide. It should be borne in mind that this adjustment is made toward the center of the machine, the point of greatest strain.

Compensation for end wear is provided in a take-up located on the rear of the cylinder, secured by adjustable brass shoes on the reel cross support, and tightened to the cylinder. The cylinder does not depend upon its bearing against the adjustable shoe resisting the end thrust, because the front of the cylinder casing is counter-bored, thus giving the cylinder a bearing on its entire periphery.

The front and rear spindle bearings are of the straight type, the material being a special bronze composition with end thrust bearings. Most important is the point that the spindles proper are not affected by wear, because a main bronze bearing is secured to the spindles and runs in a hardened steel bearing fitted to the cylinder. Moreover, the spindle gears are located centrally between the bearings instead of at the ends of the spindles; thus the pressure of the gears tends to equalize the action against the bearings on the spindle, at the same time affording rigid support by reason of the bearings being located further apart. The result of this new construction is easy rotative action, less power, higher cutting speed and easy replacement of both spindle and cylinder bearings when worn.

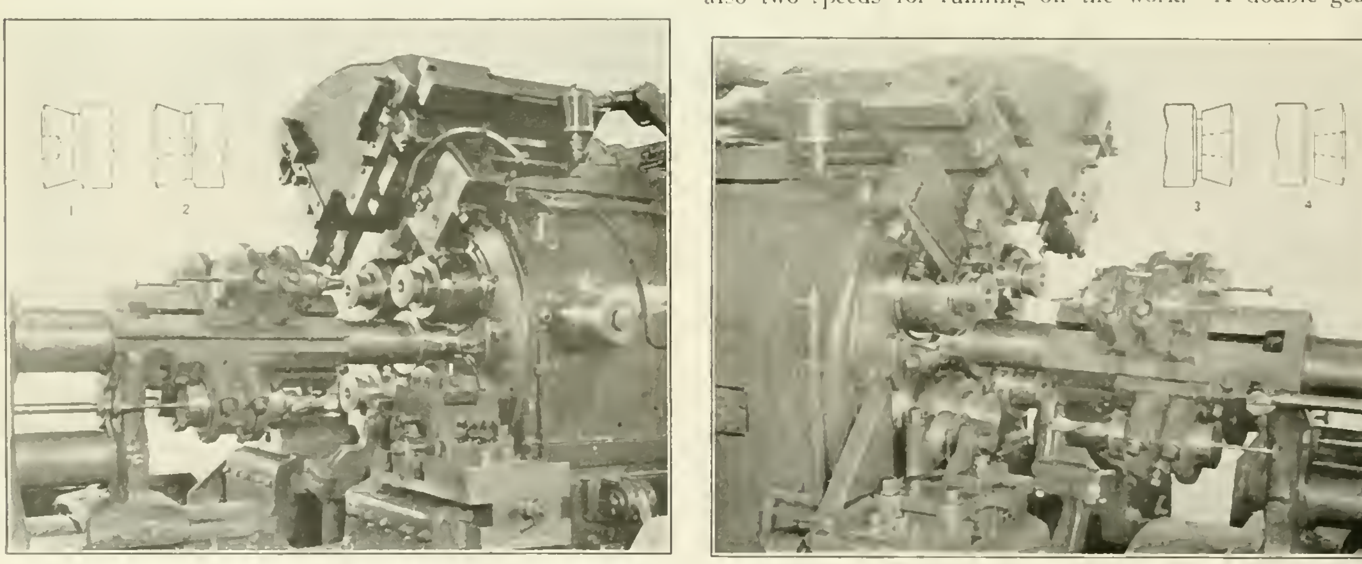
The drawback type of collet is used, the advantages of this collet as compared with the push type being five-fold: (1) they run true because they are drawn back in a taper which has been ground in the spindle itself; (2) the stock feeds more easily; (3) the collets hold more tightly under heavy end thrust, such as drilling or heavy turning; (4) there is no strain or spring at the stock stop, because in locking the stock, the bars draw back away from the stop instead of pushing against it; (5) the spindle bearings are protected when forming, because drawback chucks permit of a much shorter projection of the spindles from the cylinder.

While this machine is not fitted with the threading spindle, unless so ordered, provision is made for including it as a



Forming and Cut Off Slide Showing Adjustable Lever

part of the standard equipment. The die spindle runs right-handed. It is operated independent of the travel of the main tool carrier and has two cutting speeds, either 1 : 3 or 1 : 5 in ratio to the revolutions of the work spindles, also two speeds for running off the work. A double gear is used—one mesh for one speed and another for a different travel. Spindle speeds are varied by shifting the double gears. Change from left-hand to right-hand threads is accomplished merely by reversing the cams operating the friction. When button dies or taps are the threading equip-



Tool Set-up and Operations In Forming a Gear Blank

ment, an extra holder is used; but for opening dies or collapsing taps, only the regular equipment is required.

The turnover of the stock-carrying cylinder is accomplished by the Geneva movement and is quick, positive and with minimum strain or wear. Locking of the cylinder in the four successive positions is secured by a lock bolt on the forming side of the cylinder and a latch bolt on the cut-off side. This arrangement has been found most practical, because the lock bolt naturally pulls the cylinder down, and with this system there is less competing pressure.

Positive operation of the lock bolt is controlled by a spring directly in connection with the bolt and by a cam and roller from the main cam shaft, thus securing a rigid locking when heavy or exceptionally long bars are used.

Stock may be fed in either the first or fourth spindle positions according to the class of work in hand. The slide controlling the stock feed is independent, having its bearing on two rods between the casing and the end of the machine. It is equipped with double levers connected by rollers, and one of these rollers is changed in two positions for the 6-in. and 12-in. feeds. Intermediate feeds are secured simply by adjusting the collar on the stock pusher rod.

The pan is of unusual size constructed with three strong ribs in the floor portion and the bed which is screwed to the pan is in one piece, except the cylinder casting, which is screwed and dovetailed on as explained above. All the main gears are steel, the levers are steel castings and the main tool carrier is semi-steel.

Ample clearance is provided for chip room by the open construction below the main tool turret. The oval form of the center bed allows the chips to be washed off quickly into the pan. The general operating mechanism, forming and cut-off are under the cylinder, thus separating the chips from the working parts.

All the tools on the main tool carrier are inside the circumference of the spindles, thereby allowing for tool construction of varied sizes and shapes without interfering with each other or with the center turret extension.

The bearings for the back gears, also for the worm drive, are connected with a single oil reservoir mounted over the gear box. The feed of oil is regulated individually by thumb screws at the bottom of the reservoir, and all the oil tubes have a main shut-off so that individual adjustments do not need to be disturbed when the machine is stopped. The main spindle bearings are provided with oil chambers supplied by gravity feed cups.

Safety and convenience of operation have been carefully considered and cared for in the design of this machine. All working parts, such as gears, cam drums and friction, are completely housed. A safety device is applied direct to the worm gear on the cam shaft as follows: Instead of keying the worm to the cam shaft, a disc is keyed on the shaft parallel to the worm gear and joined with shearing pins which are easily replaced when broken. This device prevents accident, due to irregular stock feeding, mis-alinement of feed tubes and errors in setting up the tools.

In addition to the provision made for cranking by hand from the forming side of the machine, an extension, from the worm shaft to an independent stud and through to the cut-off side of the machine, allows the operator to crank the machine from either side, thus conveniently observing the movement of the tools while setting up.

The starting clutch lever for throwing into automatic feed is also controlled from either side; and when thrown into automatic feed, the hand crank is automatically disengaged, thus avoiding any possibility of accident due to negligence.

The machines are furnished either belt or motor driven. When motor driven a 10-h.p. motor is required for the 3-inch machine and a 15-h.p. motor for the 4-inch machine. Top slides, threading attachment and an accelerated reaming and high speed drilling attachment are not standard equipment furnished with the machine.

Exceptionally Large Plate Bending Rolls

One of the largest plate-bending rolls built in the central states has just been purchased by the General American Tank Car Corporation of Joseph T. Ryerson & Son, Chicago. The machine is of exceptional size, and is provided throughout with steel gears and bronzed bushed bearings. In the past it has been the custom to build heavy machinery of this kind with cast gears and either babbitted bearings or bearings directly on cast iron. This machine measures 34 ft. 2 in. between housings and has a capacity for bending ¾-in. mild steel plates. The top roll is 29 in. in diameter and weighs about 40 tons. The bottom rolls are 21 in. in diameter and have two roller supports. The rolls are mounted on a rigid cast iron sub-base and have independent motors for main drive and power adjustment of the top roll.

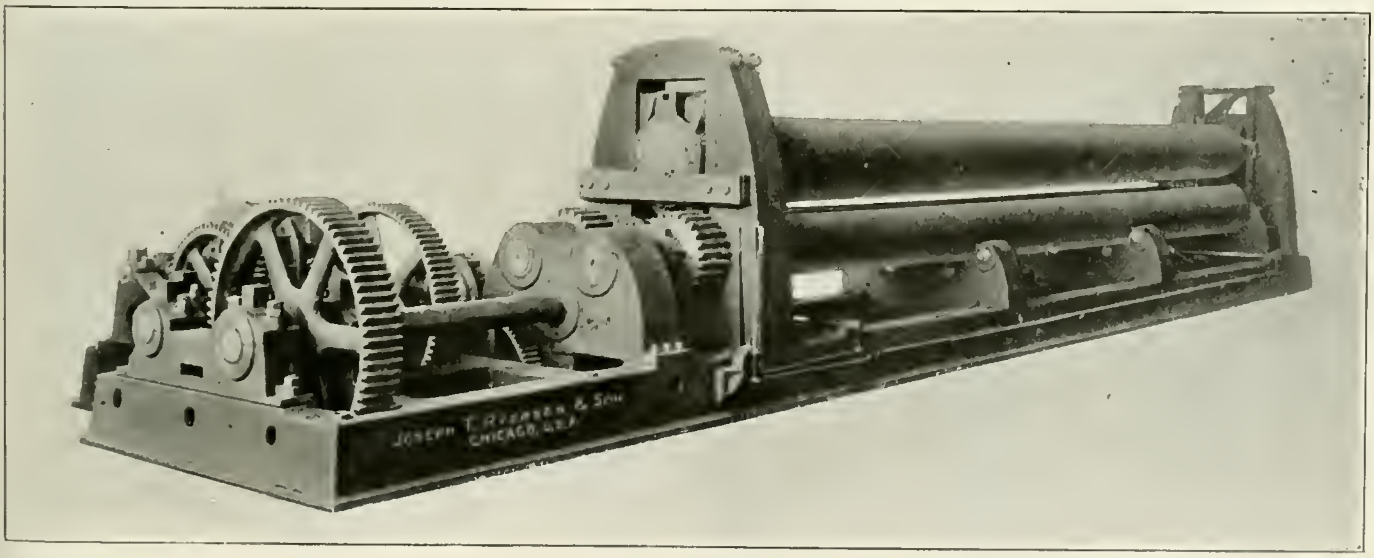


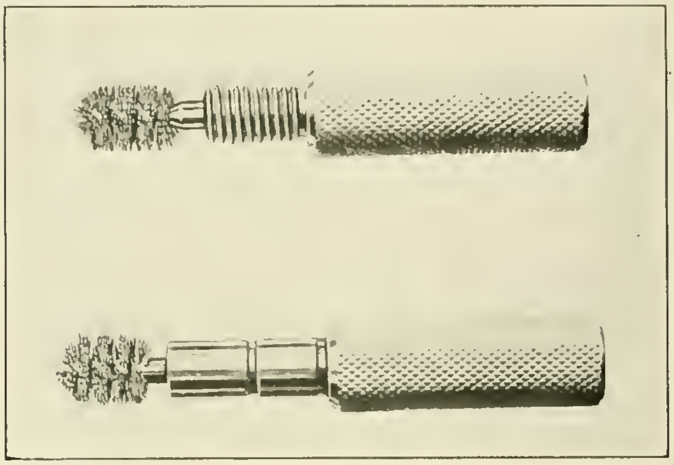
Plate Bending Rolls that measure 34-ft. 2-in. between Housings and can bend ¾-in. Mild Steel Plates.

Pilot Brush Increases Gage Life

IN order to provide a wider field for the use of plug and screw gages and to increase the life of many gages now used in manufacturing processes, a combination brush and gage has been developed and placed on the market by the Brush Pilot Gauge Company, Springfield, Mass. By the use of this combination brush and gage, more accurate testing is accomplished and the life of the gage is greatly increased because of the removal of dirt and foreign matter. The brush also acts as a pilot, thereby eliminating almost entirely the wear commonly occurring at the entrance end of the gage. More accurate testing is another advantage resulting from the elimination of end wear on the gage.

Cleaning the surface before the gage enters a test piece prevents abrasive action, and at the same time gives increased accuracy to measurements and increased speed to the inspection work. The spiral brushes are so made as to leave the bristles at slightly varying lengths and when used in conjunction with a screw gage, the bristles tend to thoroughly clean out the thread both at the top and the bottom. The illustration shows a brush applied to two common types of test gages.

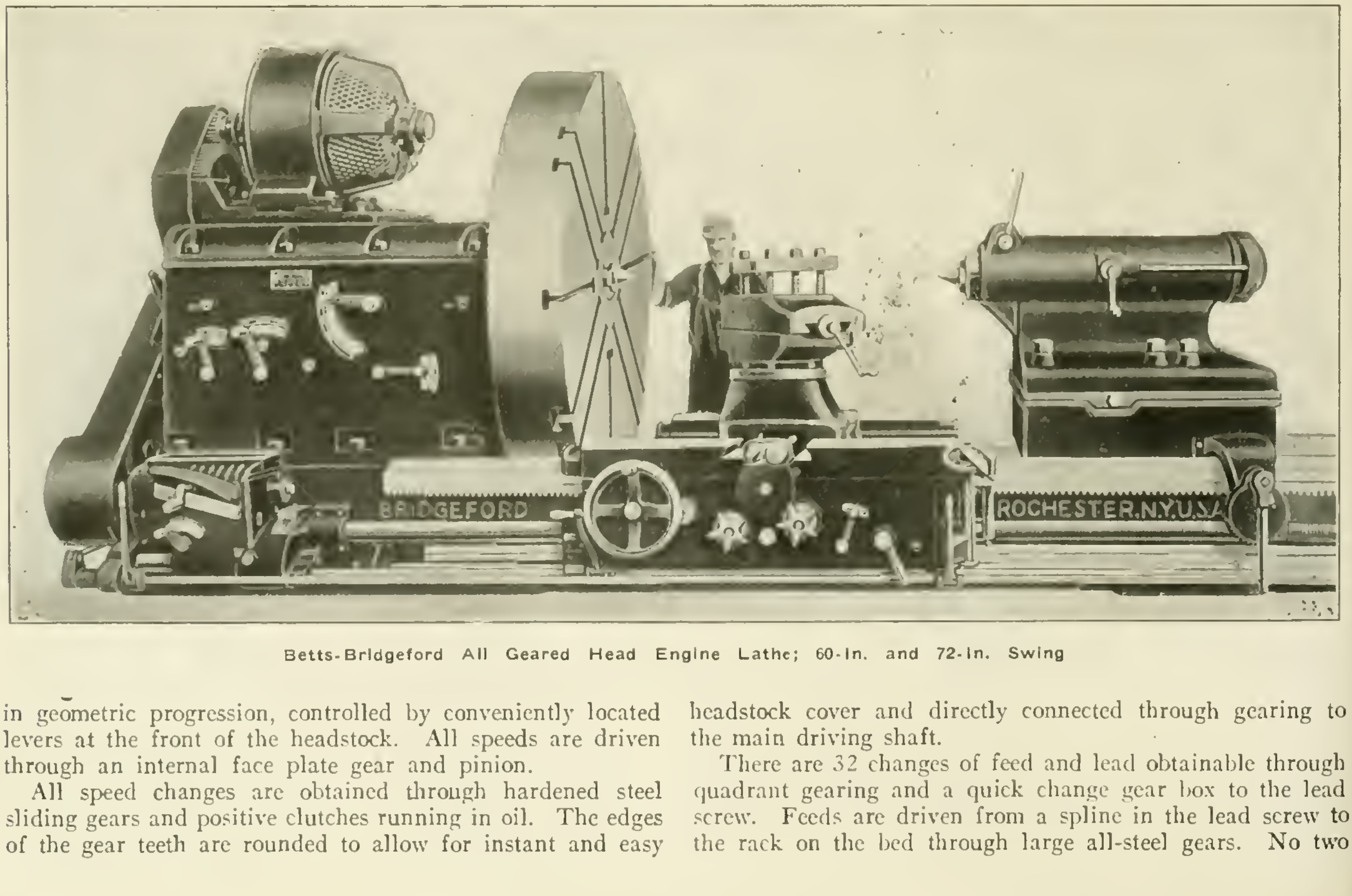
It is claimed that the pilot brush will increase the life of a test gage approximately three hundred per cent, resulting in an important saving to any manufacturing machine shop where the simplest kind of plug gage costs five dollars.



Pilot Brush Applied to Familiar Types of Test Gages

Powerful All-Geared Head Engine Lathe

A NEW, all-geared head engine lathe with a swing of 60 in. and 72 in. has been designed by the Betts Machine Company, Rochester, N. Y. The headstock is driven through a powerful expanding ring friction clutch which is operated from the apron, convenient to the operator. The same movement which disengages the clutch automatically applies the friction brake. There are 12 spindle speeds in geometric progression, controlled by conveniently located levers at the front of the headstock. All speeds are driven through an internal face plate gear and pinion.



Betts-Bridgeford All Geared Head Engine Lathe; 60-In. and 72-In. Swing

All speed changes are obtained through hardened steel sliding gears and positive clutches running in oil. The edges of the gear teeth are rounded to allow for instant and easy engagement and no two speeds can be engaged at the same time. Shafts and gears are located in the lower half or base of the headstock and not in the cover, thereby allowing easy access to all of the parts, it being necessary only to remove the cover. All shaft bearings are bronze bushed and all bearings are lubricated by means of chain oilers. When the machine is motor driven, the motor is mounted on top of the headstock cover and directly connected through gearing to the main driving shaft.

There are 32 changes of feed and lead obtainable through quadrant gearing and a quick change gear box to the lead screw. Feeds are driven from a spline in the lead screw to the rack on the bed through large all-steel gears. No two

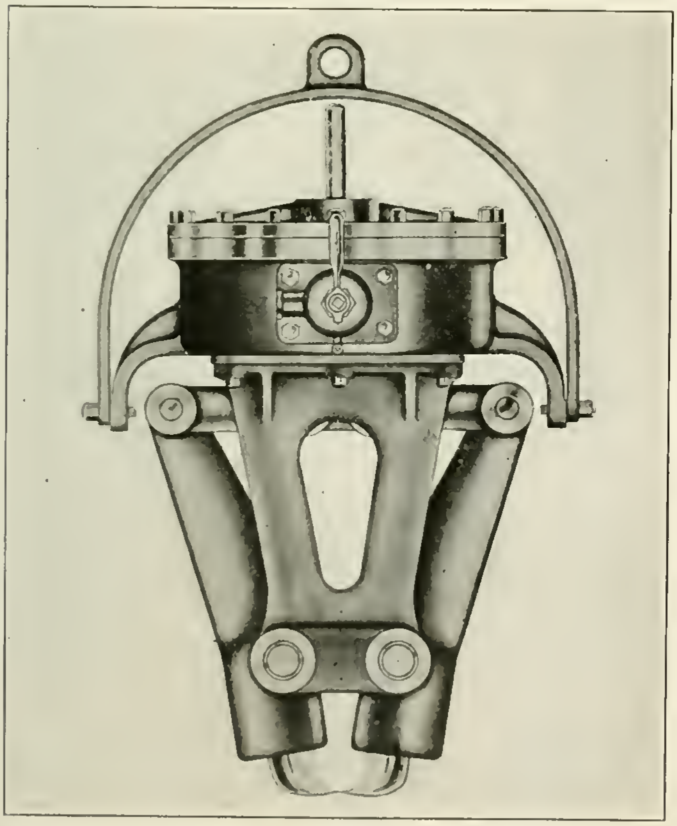
feeds can be engaged at the same time and feeds and leads are interlocking so that only one can be in use at one time.

All shafts in the apron have a bearing on each side, the apron being of double wall unit casting construction. The power angular feed to the compound rest is driven from the cross feed friction, a slip gear being provided for cross feeding or power angular feed. Both feeds and leads may also be reversed at the headstock. Power rapid traverse is obtained by means of a friction clutch on the lower shaft in the quick change box, which is driven from the constant speed headstock driving shaft by means of a Morse silent chain at the head end of the lathe. The rapid traverse is operated by a lever at the apron. The movement which engages the rapid traverse clutch automatically first disengages the feed and lead, making it impossible to have both engaged at the same time. Power angular feed is provided on the lathe.

Staybolt Cutter and Yoke Type Riveter

TWO pneumatic tools of particular interest are being introduced into railway shops by the Baird Pneumatic Tool Company, Kansas City, Mo. The staybolt cutter, illustrated, can be operated by one man and is used in clipping off staybolts up to 1⅛ in. in diameter at the rate of approximately 1,200 per hour. The machine is composed of a 15-in. air cylinder, the piston of which connects directly through a toggle joint with a pair of lever arms, into which the removable cutter knives are securely fastened. These knives are of sufficient strength to withstand the heavy pressure required in clipping staybolts. The working pressure is 100 lb.

A pressure of eighty tons is delivered to the cutter knives, which is sufficient to clip off staybolts up to 1⅛ in. in diameter. The cutter blades are so designed that, when placed against the sheet, the staybolt is cut off just the right distance from the sheet, to allow for heading over. This feature is



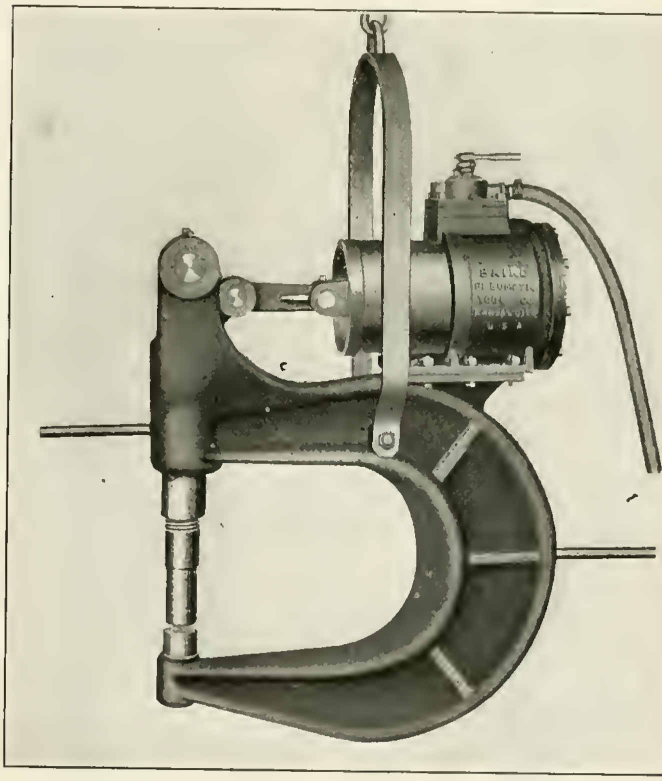
Baird Pneumatic Staybolt Cutter

a great time and labor saver and insures uniformity of work.

An additional advantage is the elimination of loose bolts caused by cutting them off with a hammer and chisel. The machine can be operated on modern radial stay boilers and is balanced to be held at any desired angle.

The length of the staybolt does not affect the operation of the machine. When long bolts are to be cut off a special pair of blades is used and the machine operates on an angle so that the bolts do not interfere. The machine is designed to be operated by one man and on account of its light construction and the convenient position of control valves, can be easily operated.

For the construction of truck frames, tank frames and locomotive boilers the yoke type riveter, illustrated, can be



Pneumatic Yoke Type Riveter

used to good advantage. The machine is equipped with a tandem cylinder having two pistons on a single rod. The necessary guide cylinder is utilized as a power cylinder and this arrangement doubles the power of a single cylinder. The stroke is short and the power is delivered with a quick direct blow. The construction obviates the necessity for large diameter cylinders of long stroke, or the double toggle or other arrangement.

The connecting rod of the riveter varies only one-half inch from a direct line from start to finish of the stroke. At the finish, when maximum power is desired, it is on a direct line. The toggle principle has the advantage of being small, compact and simple, with few bearings and little lost motion. The lever is an integral part of the lower toggle lever and develops its greatest power at the finish of the stroke. The adjusting screw is of the buttressed screw type, which has the advantage of a direct flat bearing surface, which reduces wear and lost motion to a minimum.

Because of the practical elimination of lost motion, rivets are driven rapidly with one blow before their heat is dissipated. A uniform set of each rivet therefore is obtained. Various sized cylinders can be furnished to deliver any desired tonnage to the dies. The control of tonnage delivered to the rivets can be regulated by an air line pressure valve to suit any class of work. This saves wear and tear on the machine and is economical in the use of air. Steam as well as compressed air can be used, although air is preferable. Suspension of the yoke type riveter is by a bale or link through the center of gravity, permitting operation from a horizontal or vertical position, or at any angle between. On larger sizes, foot brackets or rests are provided for installing the riveter in a stationary position by embedding in concrete. The operating handles for control valves on the standard equipment are placed on top of the cylinder.

Particular care has been given to eliminating exposed parts which might catch the clothing or person of the workman. The operation of the lever and toggle joint is such as to practically eliminate danger of personal injury.

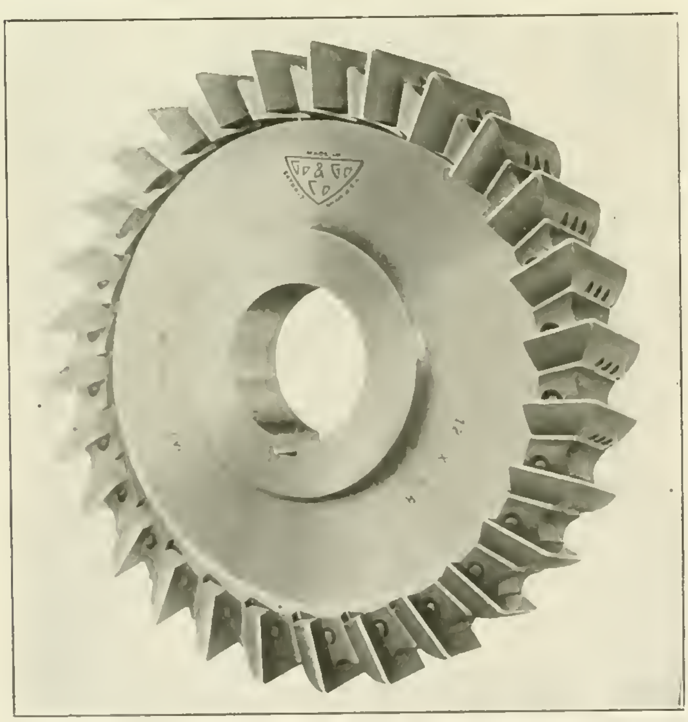
Two New High Speed Milling Cutters

BOTH solid and inserted blade milling cutters are now in common use, but improvements in design are made from time to time. Two recent developments in high speed steel cutters made by Goddard & Goddard Company, Detroit, Mich., are shown in the illustrations.

Inserted Tooth Mill

The inherent weakness in inserted blade cutters has generally been due to the fact that the blades were set radially in a soft steel body, the resulting radial cut consuming excessive power in removing metal; also, the severe use accorded these cutters often makes the soft steel body comparatively short lived.

In the inserted tooth mill, illustrated, maximum strength of tooth has been secured with maximum chip clearance. The blades are set at the same angle as in solid mills, giving a shearing action, which removes the maximum amount of metal with the minimum consumption of power. The body is made of alloy steel, heat treated to an elastic limit of approximately 105,000 lb. per sq. in., which, combined with



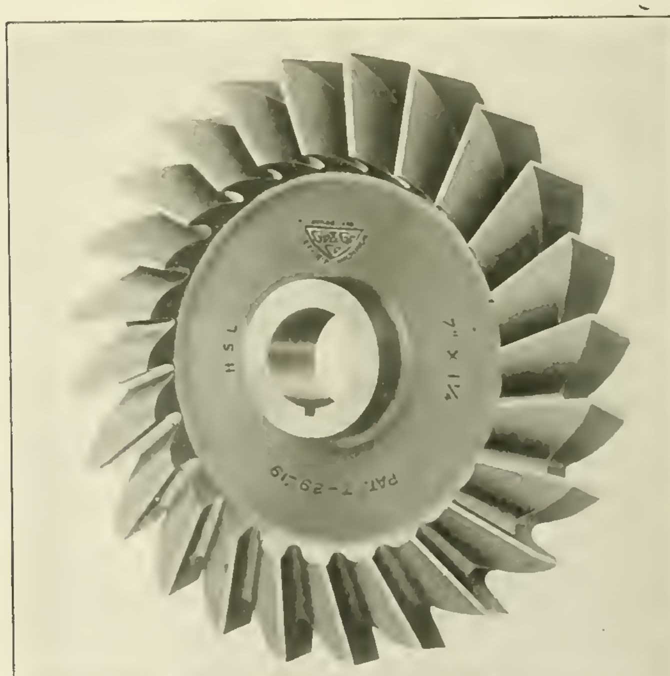
Goddard & Goddard Inserted Tooth Mill

extreme toughness, makes it able to withstand heavy feeds and speeds.

The blades are held in the body by the well known wedge pin method, thus giving maximum strength to the tongue of body metal between the teeth. In addition, the blades are positioned positively against lateral thrust by dowel pins inserted in the periphery of the body. This arrangement also increases the life of the blades, as it will be noted that multiple notches allow three possible positions of the blades as they are ground down. The final setting of the blades maintains two-thirds of their length in the body of the cutter, thus giving adequate support. These cutters are made to be used in gangs, right and left, or bolted to a flanged spindle. They are recommended for work requiring cutters of 10 in. in diameter or larger.

Half Side Mill

The great volume of milling known as straddle work has usually been done by milling cutters provided with teeth on the periphery and both sides, the idea being that when the



Half Side Mill With Deeply Cut Teeth

inside counter of each mill in a gang becomes dull the cutters can be transposed and a double amount of work done with a set of cutters at one grinding. The half side mill illustrated has teeth on the periphery and one side only. It will be noted, however, that the peripheral teeth are on a spiral, as well as being undercut. The following advantages of this arrangement may be mentioned: Spiral peripheral teeth, undercut on both the peripheral and side teeth, and a patented tooth form, which provides maximum tooth strength and chip clearance. These factors combined produce easy shearing action at the point of the tooth, where the service is most severe. In fact, each tooth is practically a diamond point and removes its share of metal with the

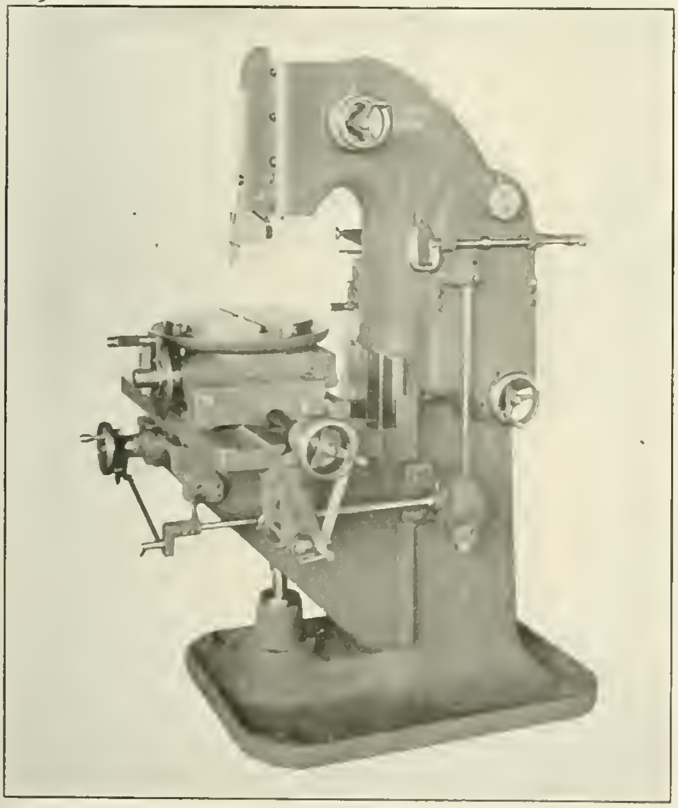
same ease, freedom and finish as a diamond point properly ground and set in the toolpost of a lathe. Further reference to the illustration of the half side mill shows the side teeth to be much deeper than ordinary. This feature allows more grinding and adds to the ultimate life of the cutter more than is possible with the ordinary side mill.

Goddard & Goddard half side mills are made in sizes varying from 4 in. to 9 in. in diameter. The center holes vary in size from 1¼ in. to 2 in., these relatively large sizes being necessary on account of the heavy work for which the cutters were designed. Both milling cutters described in this article are made of high speed steel only.

Vertical Shaper for Tool and Die Work

THE manufacture of many tools, punches and dies for railway shop work involves certain machine operations that can be performed to good advantage on the vertical shaper illustrated. The machine is manufactured by the Hanson-Whitney Machine Company, Hartford, Conn., and especial care was taken to make it capable of rapid, accurate work. The ram travels rapidly and the entire shaper construction is rigid. Although of a comparatively small size, the machine has a large range and a large size die can be swung in all directions without interference. On the other hand, small tools for fine operations can be used.

In several respects the Hanson-Whitney vertical shaper differs from the type where a reciprocating ram is used for the action. Among other things the length of stroke can



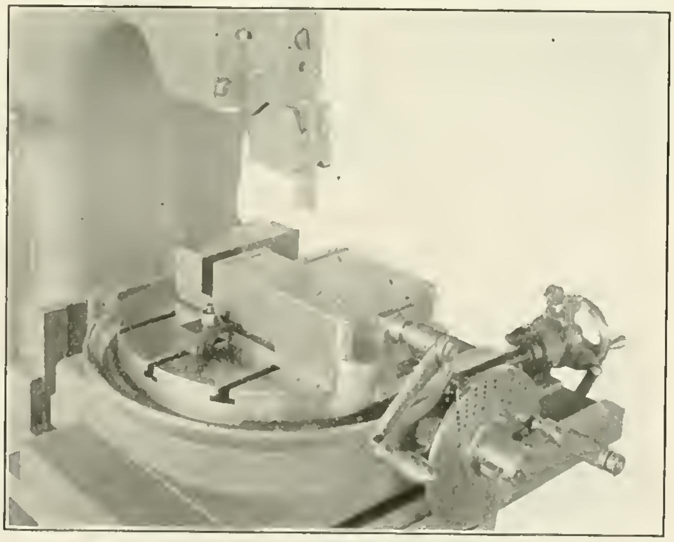
Hanson-Whitney Vertical Tool and Die Shaper

be adjusted whether the machine is running or still and with equal facility. This adjustment is made with the handwheel shown on the side of the column, near the top, the entire mechanism being of simple and durable construction.

An elk horn shaped handle, shown on the right side of the column, controls the starting and stopping and when the machine is stopped, the ram will automatically stop on the end of the up stroke. This will occur no matter when the handle is placed in the stopping position.

Another advantage is that the tool on the back-stroke positively recedes from the work and on the down-stroke positively engages with it. Therefore, the edge of the tool does not drag on the work. Referring to the more detailed illustration, it is evident that no set screw or projecting obstacle on the tool holder prevents the ram from clearing the work. In other words, a long overhang of the tool is not necessary when planing the outside of a piece, and when planing the inside of a piece, such as a die, it is only necessary to have the overhang of the tool as long as the cut to be taken. The standard tool illustrated is made with a clearance and when sharpened needs to be ground only at the end. All working surfaces in connection with the clapper mechanism are made of hardened steel and ground.

Besides the rotary motion of the table, it can be tilted so that dies can be made with a clearance when desired. A segment, graduated in degrees, indicates the amount of taper that may be desired. The feed screws on the slides have micrometer dials graduated to .001 in. The machine is driven through a tight and loose pulley on the left hand side of the column and three speeds are provided. The fast



View Showing Details of Tool Post and Double Gap Vise

driving pulley runs constantly, thus making it possible to drive the machine directly from the main shaft and eliminate a countershaft. An interlocking device prevents injury to the gears. The machine is controlled by the elk horn shaped handle, which operates an expanding friction clutch and drives the ram. About halfway down on the right side of the column there is a handwheel by means of which the machine can be turned by hand when setting up a piece of work, so as to make sure that there is no interference. As indicated, the knee is adjustable for positioning the stroke.

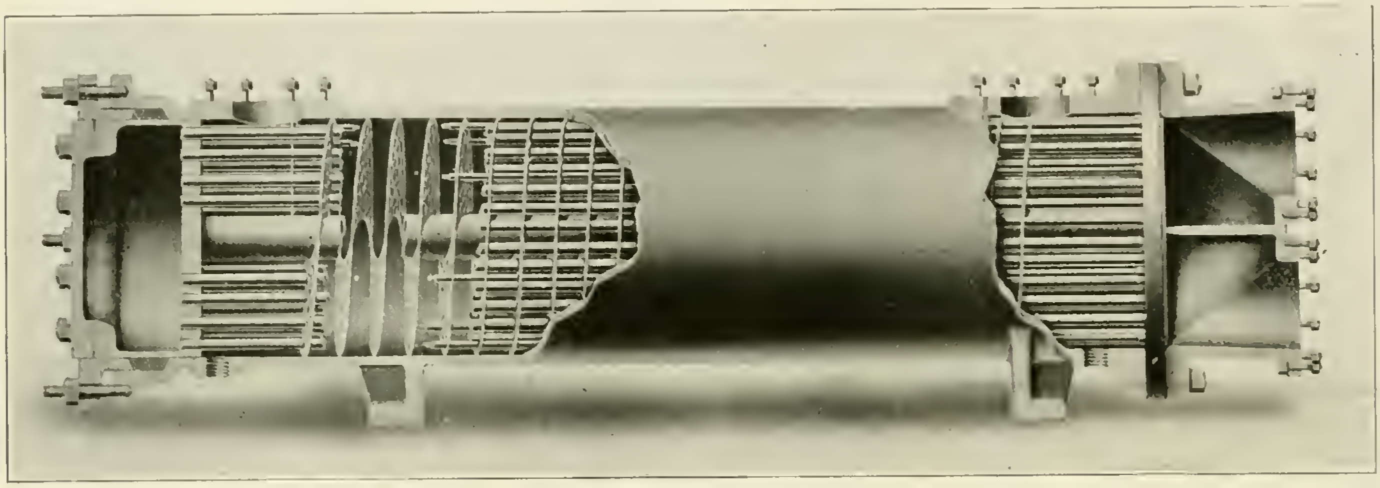
The stroke of the ram is 4¼ in. and the maximum difference from the table top to the end of the ram is 10½ in. The diameter of the rotary table is 14 in., the longitudinal and transverse travel being 15 in. and 8 in., respectively. The table can be tilted up to five degrees. The number of strokes per minute for each speed are 66, 114 and 200. The work vise, illustrated, is furnished only when ordered. It is made for holding small pieces and a 2-in. and 4-in. gap has proved a great convenience in setting up small jobs.

Cooler for Lubricating and Quenching Oils

An ingenious device for the cooling of oil used in lubricating turbine bearings, or quenching oil in the heat treating of steel, has been developed by the Griscom-Russell Company, New York. Circulation through the cooler maintains the oil at a constant temperature and permits the continued use of the original quantity of oil and its maintenance at the proper viscosity for efficient results.

The apparatus takes its name from the whirling path of the oil, caused by the use of a helical baffle which directs the flow of oil without appreciably retarding its progress. This baffle also serves to bring the oil into intimate contact with the cooling surface and insures a high rate of heat transfer.

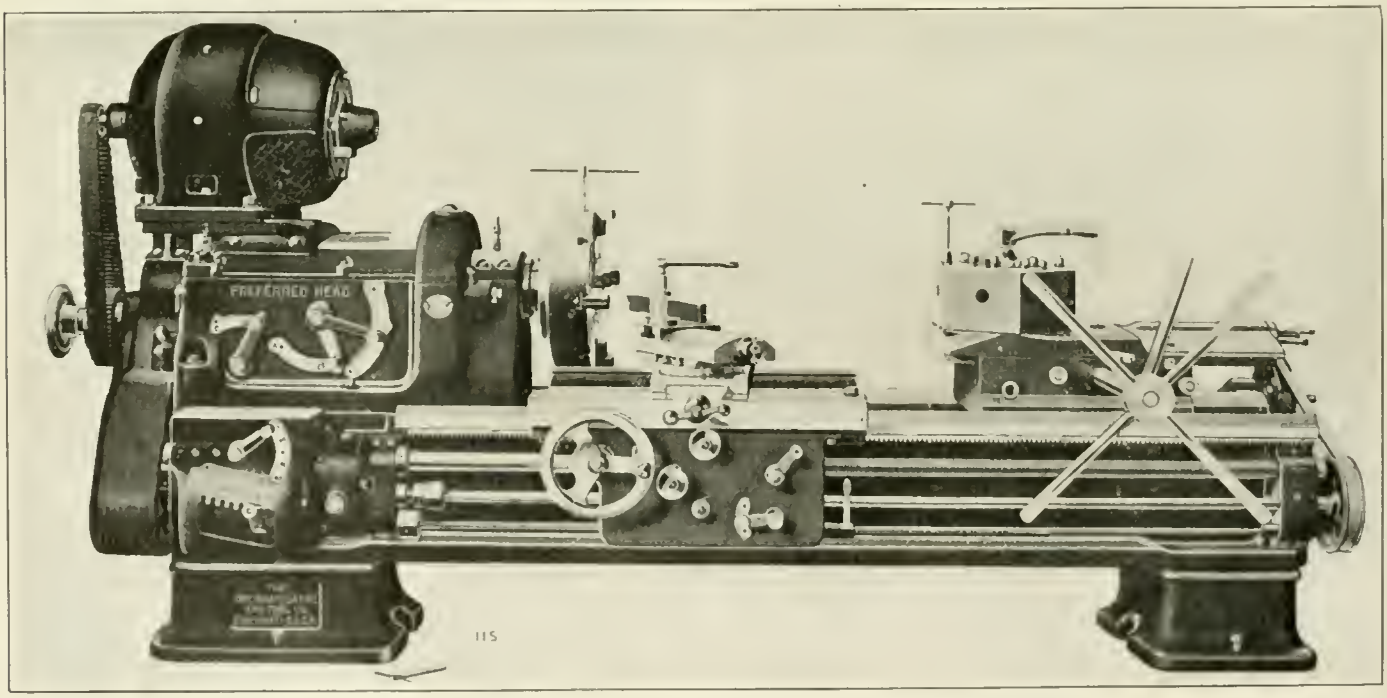
The shell is of cast iron and the tubes of seamless drawn brass or copper, expanded into a fixed tube plate at one end and into a floating head at the other. This permits expansion and contraction without strain on the tube joints. The cooling of quenching oil insures maintenance of the quenching bath at a fixed temperature and also permits the use of a cheaper grade of oil.



Griscom-Russell Multiwhirl Cooler

Cincinnati Geared Head Lathe

The machine illustrated below is one of a line of geared head engine lathes manufactured by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio, and previously described on page 174 of the March *Railway Mechanical Engineer*. These machines are now being made with three different types of drive, including belt drive from the main line shaft, motor drive with the motor mounted at the side or rear of the head and the arrangement illustrated, in which



Cincinnati Lathe Provided with Hexagon Turret and Driving Motor on the Headstock

the motor is mounted on the headstock. This arrangement takes up a minimum of floor space, but in case the motor would interfere with overhead jib cranes or traveling cranes, it may be placed either at the side or rear of the head and drive through a silent chain. The illustration shows the lathe equipped with a hexagon turret.

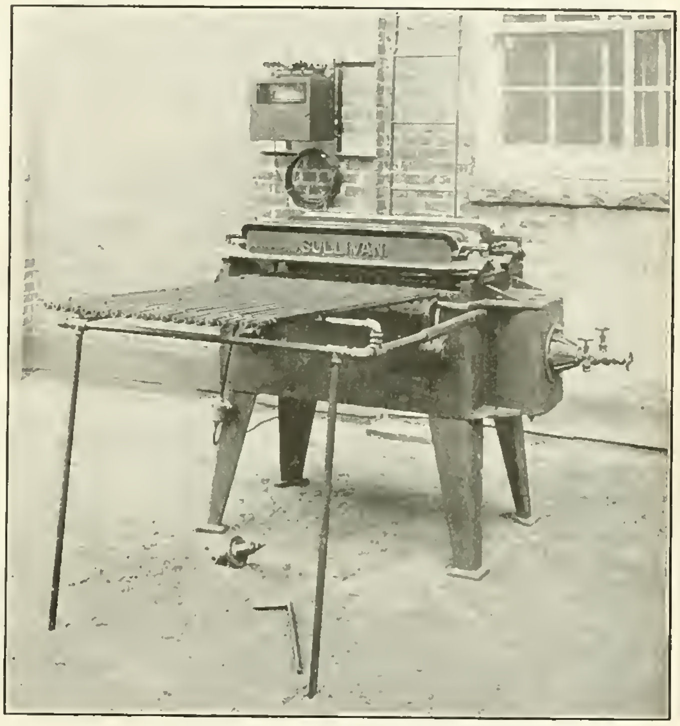
An Adaptable Drill Steel Furnace

While the drill steel furnace illustrated was designed by the Sullivan Machinery Company, Chicago., Ill., especially for the efficient sharpening and tempering of drill steel used in mines and quarries, the field of usefulness of the furnace is not limited. Due to its general convenience and adaptability, it is suited for certain other heating purposes such as heating bars, bolts, rods, or coupling pins in railway shops.

In construction, the furnace consists of a rectangular cast iron box with a lining of firebrick having adjustable hearths and hoods, a burner or atomizer being attached at one end. The furnace is set at a convenient working height and an adjustable support carries the outer ends of the work. When it is desired to maintain a constant known temperature as in the hardening of steel, a pyrometer is used. A convenient arrangement of the pyrometer is shown in the illustration with the meter attached to the back wall.

Among the advantages of the Sullivan furnace may be mentioned the possibility of obtaining uniform temperatures without danger of overheating, large capacity, economy of fuel and compressed air, adaptability to different kinds of fuel such as oil or gas, flexibilty providing for adjustment to heat any portion of the work desired, ease of adjustment and repair, and low cost of maintenance.

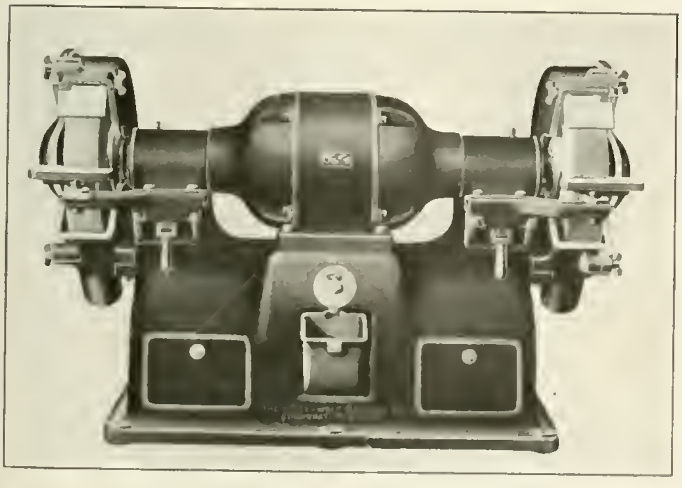
In operation, combustion takes place over the entire length of the combustion chamber of the furnace. The so-called cold end is that next the burner and the hot or finishing end is that farthest from the burner. With the furnace operating properly, an even flame is produced, a small portion of which comes up through the opening in the combustion chamber between the hearths at the hot end. The greater portion of this flame, however, is confined in the combustion chamber and produces a uniform reflected heat on the work.



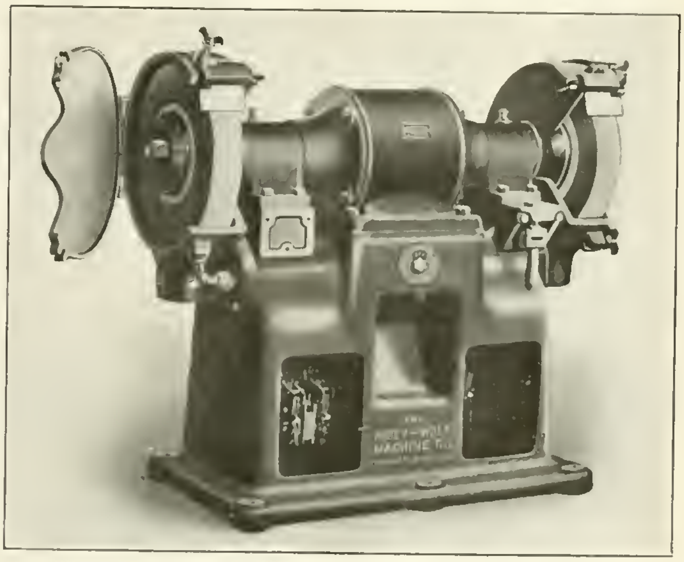
Sullivan Furnace and Pyrometer Installation

Self-Contained Motor-Driven Grinder

A new ball bearing grinding machine, driven by a self-contained 10-hp. motor, has been placed on the market by the Hisey-Wolf Machine Company, Cincinnati, Ohio. This machine, shown in the illustration, is designed to use two 24-in. grinding wheels, 4 in. wide. Friction losses are reduced to a minimum by the use of SKF ball bearings mounted in the motor end caps, in close proximity to the grinding wheels. The construction of the bearing housing is such as to permit correct mounting from the exterior of the motor, a feature which increases the efficiency of the bearings and holds the armature spindle per-



Hisey-Wolf Ball Bearing Grinding Machine



View Showing Quick Acting Switch and Adjustable Steel Guards

manently in correct alinement. The importance of this feature can hardly be overestimated.

The generous and rugged proportions of the machine reduce vibration to a minimum and enable it to stand up under heavy duty and produce a uniform finish on all work ground. Not only is the friction loss in the grinder reduced to a minimum, but it is claimed that a grinding wheel lasts longer because, after once being balanced, it does not require frequent dressing.

Each machine is fitted with a quick acting switch, as shown in the detailed illustration and the larger sizes of grinder have an automatic starter equipment. The operating handle is located as shown in front of the motor, with the switch proper completely enclosed in the bed. This method of mounting insures protection and also permits ready access to all the switch mechanism by simply removing the cover plate.

Special attention is called to the wheel guards, which are made of steel to insure all possible protection. These guards enclose the grinding wheels for three-quarters of the circumference, are adjustable, and are so designed that the wheels can be removed independently. The water pot and pool tray are separate detachable units.

Arrangement can be made for either direct current or alternating current motor drive and in either case the motor is especially designed for the particular machine on which it is used. The Hisey-Wolf grinding machines are made in six sizes from ½ hp. to 10 hp. capacity.

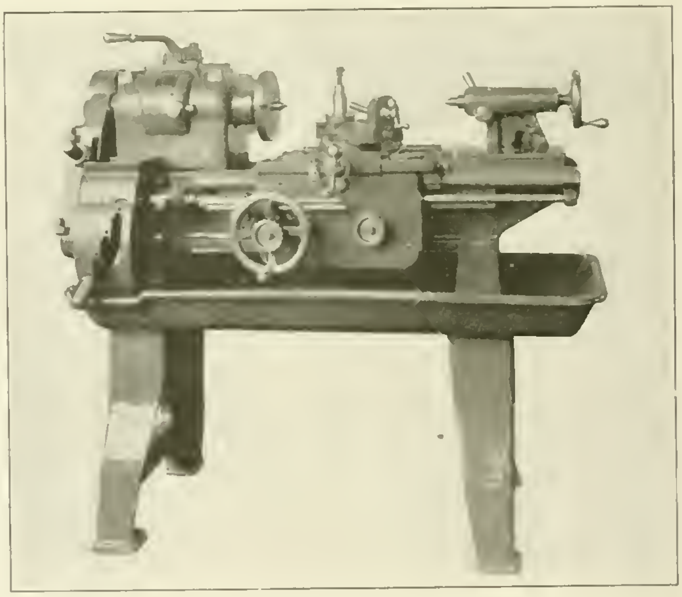
Short-Cut Lathe of Improved Design

A SHORT-CUT lathe with several important improvements not incorporated in the original machine has been placed on the market by the O. R. Adams Manufacturing Company, Rochester, N. Y. The lathe swings 13⅝ in. and is designed to take 20 in. between centers. It has a single pulley drive through a geared head and six changes of speed are obtained through an operating lever and knob. The operating lever provides two changes, the lever being placed so that the lathe can be started and stopped without making it necessary for the operator to move from his position in front. The neutral position of the lever applies a brake to all revolving parts, bringing the spindle to rest immediately.

All gears in the head run in a bath of oil and are of steel with the exception of the large gear on the spindle. The spindle itself is made from a special grade of alloy steel, ground accurately to size. It runs in phosphor bronze bearings which are adjustable and has an SKF self-alining ball bearing to take up the end thrust.

The carriage feeds are eight in number, obtained through a gear box with a tumbler gear, which provides four changes of feed. These vary from .006 to .025 with end gears in one ratio and a further range of feeds from .010 to .042 when the end gears are reversed. The carriage has power cross feed and the rate is indicated on the index plate mounted over the gear box. The direction of feed can be changed through a reverse lever mounted in a supplementary gear case at the headstock end of the lathe. All operating handles are conveniently located.

The carriage has a compound rest so arranged that it can be changed to either a four sided turret toolpost, combined front and rear tool rest or plain rest, without any additional fitting. The apron is of the double plate type with the two halves in contact, thus forming a box section of strength and rigidity. Each lathe is supplied with an oil pan bed of sufficient size to prevent any cutting compound getting on the floor.



Adams Short-Cut Lathe

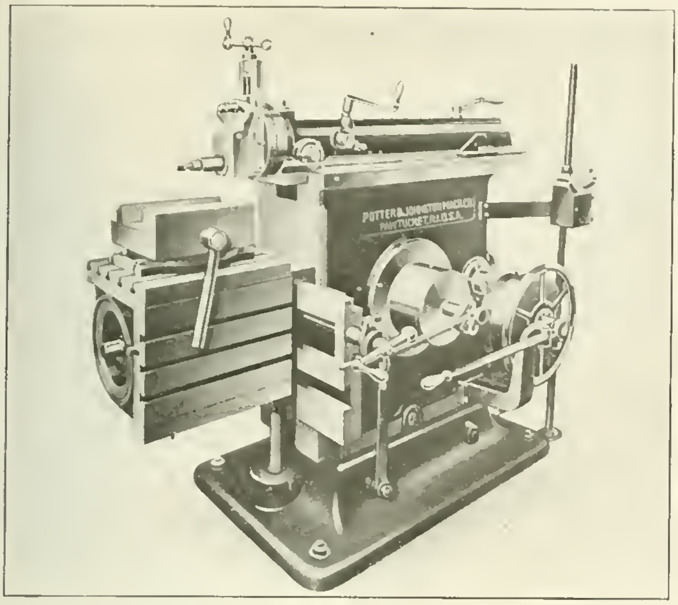
Universal Shaper With Unit Gear Box

THE 24-in. universal shaping machine described in this article is made by the Potter & Johnston Machine Company, Pawtucket, R. I., and particular attention is called to the gear box, which is a unit within the base of the machine. All the universal features necessary for die and tool work have been incorporated in the machine, which is at the same time well adapted for general manufacturing purposes or repair shop service. All control handles are on the right hand side of the shaper.

A heavy column, of correct design to withstand all ordinary strains, is securely fastened to the base of the machine. The total length of the base is 34 in. A large gear gives reciprocating motion to the ram by means of a wrist pin carried in a disk set eccentric in the gear. A graduated dial on the outside of the machine provides for adjustment to give different lengths of stroke. The ram is held securely down to its seating by means of rectangular straps on top of the column. A rectangular gib on one side of the ram provides for taking up wear.

Power down feed for the tool head is operated by the movement of the ram against an adjustable feed cam dog, located along the side of the ram. This cam is capable of adjustment while the ram is in motion to obtain practical variations in the amount of feed. An adjustable stop at the side of the ram positively controls the down feed of the tool slide to any predetermined point. The table can be swiveled around a central pivot and is revolved by means of a worm carried in the table and engaging in teeth cut in the periphery of the pivot. One side of the table has an auxiliary tilting portion for obtaining compound angles. The

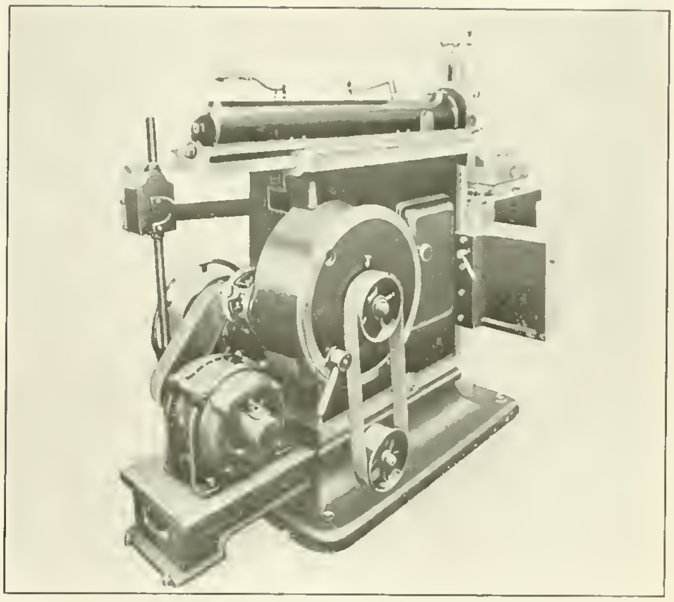
cross slide is exceptionally deep and accurately scraped to its bearing against the column. The table and cross slide are elevated and lowered by means of a power operated



Potter & Johnston Universal Shaper

screw. The weight of these parts is carried on a ball bearing surrounding the elevating screw.

The gear box provided with the shaper is a unit with the base. Five speeds are obtainable by a movement of the shipper lever, which is located conveniently for the operator. The machine can be supplied with either motor drive or



Rear View Showing Motor Drive

single pulley drive. When motor drive is desired, a 5-hp. constant speed motor is recommended, the drive being through a silent chain.

Snap Thread Gages for Accurate Inspection

A SNAP thread gage for accurate inspection of numerous threaded parts has been developed by the Herrmann Gauge Company, Detroit, Mich. This gage is shown in Fig. 1, which also indicates the adjustable jaws. For many purposes the snap thread gage has important advantages over the plug type thread gage. Its use eliminates the necessity of catching the thread and screwing the work into the gage and with the snap gage, all of this time is saved. In operation, it is used like the snap gage on cylindrical

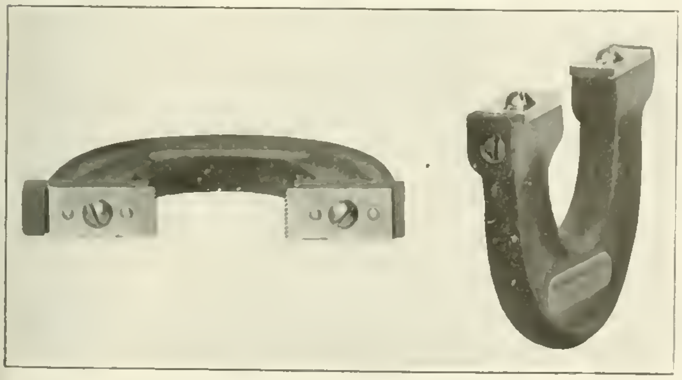


Fig. 1—Herrmann Snap Thread Gage

work. Since the work is not screwed into the gage, wear does not take place as usual, and it has been found that the size is maintained indefintely. The blades are made of hardened steel and will last a long time.

Because the parts are simple, the working surfaces can be accurately cut and lapped to any desired shape. Both jaws are made adjustable, as indicated in the illustration, and can be sealed to prevent a change in the setting. These snap thread gages are made in sizes from 1/4 in. to 3 in. and with a variation of pitch from 8 to 27.

The snap gage designed for use as a limit gage is shown in Fig. 2. This tool can be used to good advantage in test-

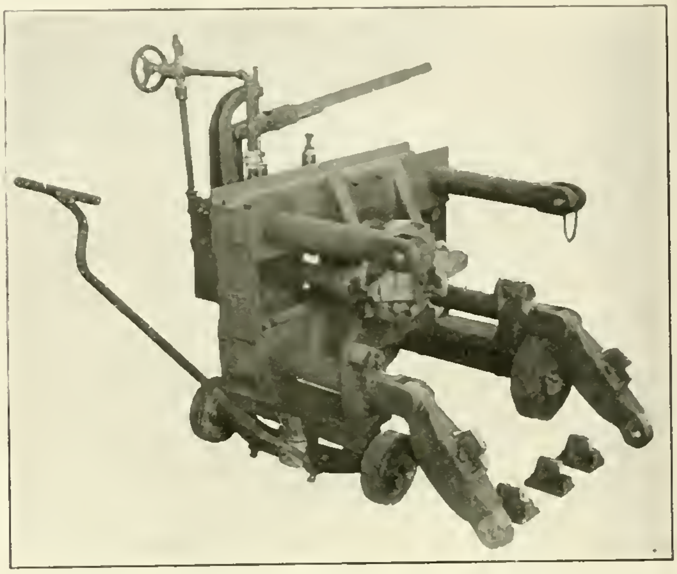
Fig. 2—Limit Snap Thread Gage

ing threaded work where it is desired to maintain the accuracy within two set limits. The limit gage is made in the same sizes as the snap thread gage.

Hydraulic Rail Bender of 35 Tons Capacity

THE hydraulic rail-bending press illustrated was designed and built recently by the Hydraulic Press Manufacturing Company, Mt. Gilead, Ohio. As indicated, the press is of the horizontal type on wheels, and can be moved readily to any desired point. The capacity is 35 tons pressure. While of comparatively light construction, the press is rigid and of ample strength for the severest kind of service likely to be required of it. Four cast steel strain rods are rigidly attached to the double I-beams, the latter being formed like clevises at their outer ends. Steel hinge pins at the bottom and steel locking pins at the top pair of strain rods provide for connecting the two steel resistance heads when bending a rail. Each of the bottom strain rods has a steel roller mounted in such a way that when a rail is in the press it may be moved easily, in order to apply the pressure at different points.

The press is fitted with a class DD hand pump, spring safety release valve and a T-screw operating valve. The pump may be used for either high or low pressure. The low pressure may be used until the bending block meets the rail and the operator cannot work the pump, then the high pressure is used. The T-valve is closed when the pressure is applied and opened when the pressure is to be released. The spring pull-back device, which is enclosed in the two small sized cylinders, returns the ram to its initial position. In case a gage should be desired on the pipe line, it may be attached at the upper connection of the T-screw valve.



Portable Hydraulic Rail Bender of Improved Design.

Potter & Johnston Vertical Type Automatic

IN addition to a horizontal automatic, the Potter & Johnston Machine Company, Pawtucket, R. I., has placed on the market a vertical type of automatic chucking and turning machine designed to meet the demands of manufacturers having limited floor space. On all machines there are five combinations of three automatic variations of speed, giving fifteen spindle speeds in geometric progression from 14.3 r.p.m. to 140 r.p.m.

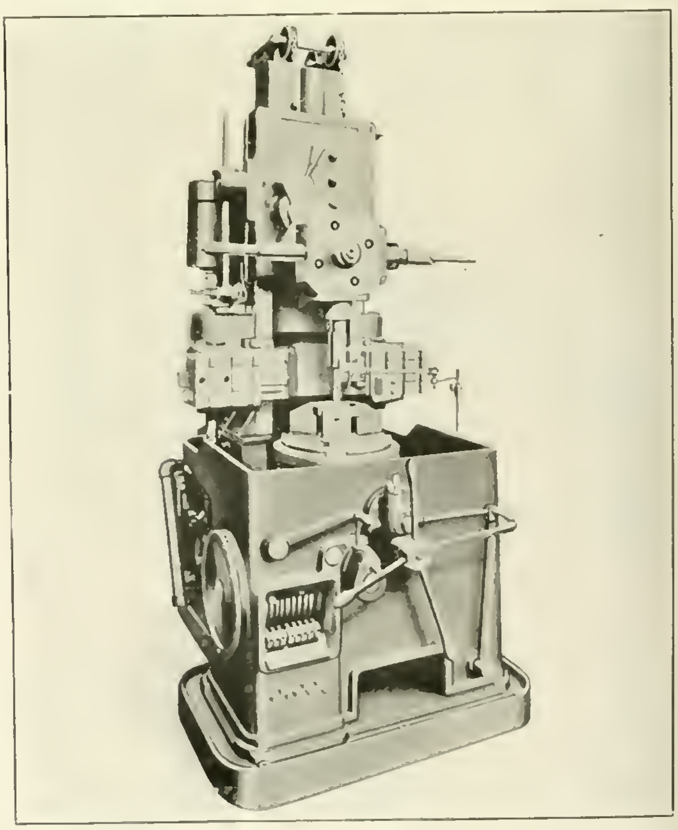
There are nine combinations of two automatic variations of feed giving eighteen feeds from .005 to .060 in. per revolution, and a threading and reaming feed from .050 to .125 in. per revolution, which allows the cutting of threads from 8 to 20 per in. The feeds are independent of the high constant speed for idle movements of the turret slide, while withdrawing and advancing the tools to the point of cutting.

The cross slide has a feed of 5 in. each way. The right and left hand side of the cross slide operate independently by screw feed, and can be arranged to feed into the work at any predetermined time, and at any desired relation one to the other.

The turret slide is of rugged construction and travels on ways so designed that all wear will be even and will not affect the accuracy of the machine. The turret slide has 14 in. feed and no allowance needs to be made for revolving as the turret revolves at the extreme end of its travel.

A 16-in. three-jaw scroll chuck is regularly furnished with each machine. This chuck is provided with a pilot bushing to receive pilot bars for supporting the tools during the cutting operations. The chuck jaws are operated by a pilot wheel at the front of the machine, which has been designed so that while the operator is using the pilot wheel it is impossible to throw in the feed, thereby eliminating danger of accident. The oil pump and piping and oiling arrangement through the turret are furnished on machines handling material requiring a lubricant.

As the machine is equipped with a single pulley drive, the motor application is simple. The motor is mounted on the upright at the rear of the machine, and the connection is by belt to the driving pulley. A 7½ hp., constant speed motor is recommended, and through change gears the same variation of speeds and feeds are obtainable as on the belt-driven machine.



Potter & Johnston Vertical Automatic Chucking and Turning Machine

The Potter & Johnston vertical automatic has a swing over the ways of 23 in. and over the cross slide of 16 in. The turret has four faces. The holes in the turret are 2½ in. in diameter by 4½ in. deep. The distance from the center of the turret to the top of the turret slide is 4½ in., the maximum travel of the turret slide being 14 in. The turret feed is 14 in. and the turret slide adjustment 8 in. The length of turret slide travel, which permits of supporting or piloting tools, is 14 in. A minimum amount of space is required for this machine, due to the fact that the maximum width and length of bed are only 40 in. and 59 in., respectively. The total height of the machine is 8 ft. above the floor.

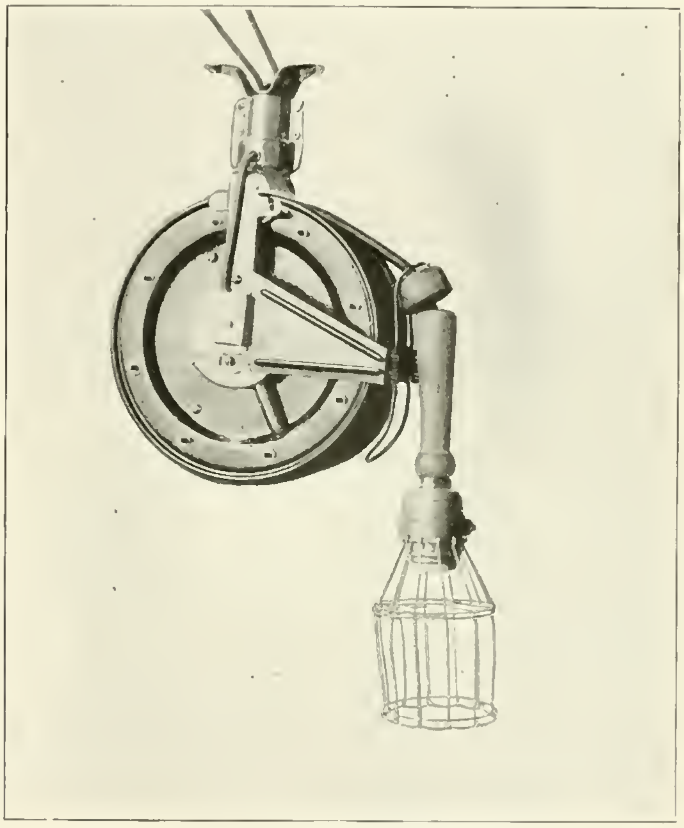
General Purpose Automatic Extension Reel

AMONG other uses, the automatic extension reel illustrated has proved of value in increasing the life of insulated electric cord used as extensions for portable drills, grinders and fans, as well as electric lights. Any one familiar with railway shops and especially railway shop tool rooms where the electric light cords are received after each day's work, will remember the frayed and worn appearance of many cords. Under the severe use accorded them, which includes pulling over the erecting shop floors and rolling trucks over them, the life of electric light cords is often short.

Not only do the ordinary extension cords have a relatively short life, but it is necessary to maintain an extra large number in stock due to the fact that in railway shops, forehanded mechanics anticipate the occasional need to light a dark corner by keeping extension cords and lights in their boxes. This condition can be remedied by installing an automatic reel permanently in the dark corner referred to.

Among the advantages of the automatic extension reel may be mentioned: longer life for the cord, light, fuses and guards; less danger of fire due to short circuits; and more convenience in operation due to the slack cord being rolled up at all times.

The reel is of simple, durable construction, and its actual size is 9 in. in diameter by 2 in. wide. It is equipped with 25 ft. of reinforced weatherproof cord. The head is provided with a swivel joint, enabling the lamp to be carried in any direction from the reel, while an automatic lock permits a positive stop at any desired point. It is insulated to withstand a test of 1,250 volts. In operation, the light or motor is taken in the operator's hand and carried to the desired distance, when a slow motion backwards causes the automatic lock to catch and hold the cord at that point. To release, a slight pull is given on the cord. This unlocks the catch and the cord is automatically rewound as the operator walks towards the reel, with lamp or motor in hand. The device is manufactured by the Cincinnati Specialty Manufacturing Company, Inc., Cincinnati, Ohio.



Autex Automatic Extension Reel

Independent Pneumatic Motor Hoists

PNEUMATIC motor hoists of one-half, one and two tons capacity have been placed on the market by the Independent Pneumatic Tool Company, Chicago, Ill. These hoists are made with two different lifts as follows: ½-ton and 1-ton hoists, 20 and 40 ft.; 2-ton hoist, 20 and 10 ft. The speed of lift for the ½-ton, 1-ton and 2-ton hoists is 32, 16 and 8 ft. per min., respectively, and the air consumption is 1.9, 3.8 and 7.6 cu. ft. per foot lift, respectively.

Equipped with a large worm gear drive, the worm is cut to a pitch that locks the drum and holds the load at any required point, even when the air is turned off, or the air line breaks. If necessary, the motor can be taken out for repairs while the load is suspended. An automatic stop prevents injury to the load or hoist by shutting off the air just before the cable is fully wound or unwound. The automatic stop can be adjusted or set for any lift, long or short, within the capacity of the hoist. The drum cover contains a permanent eyelet for the temporary cable used in placing the hoist in position, thus leaving the hook free for permanent attachment.

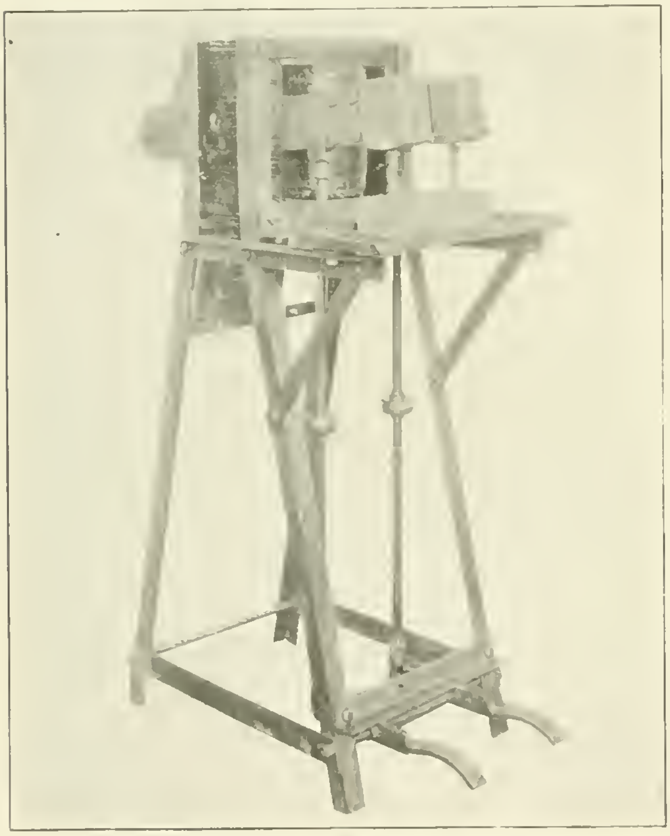
The throttle valve of the motor has a graduated opening, which makes it easy to control the speed of the motor and start or stop it gradually. The motor is reversed by shifting an eccentric, operated by the chains. The cables and drums are placed far apart to prevent the load from twisting or turning. The drums are spirally grooved and a guide on each drum leads the cable into the spiral groove and prevents climbing, crossing and cutting. The cable is protected by the drum covers and attached to the drum with a large radius bend, to prevent its kinking or weakening under heavy strain.

The motor is of the close-quarter drill type and has a relatively small air consumption. The cylinders are double acting and use a single throw balanced crank shaft, which is connected with the worm.

Electric Rivet Heaters for Railway Shops

ELECTRIC rivet heaters possess certain inherent advantages which may cause them to be used extensively in the railroad field. Three of these machines have been recently placed on the market. These are, respectively, the Berwick rivet heater, manufactured by the American Car and Foundry Company, New York; the Humil heater, manufactured by the Humil Corporation, New York, and the General Electric heater, manufactured by the General Electric Company, Schenectady, N. Y.

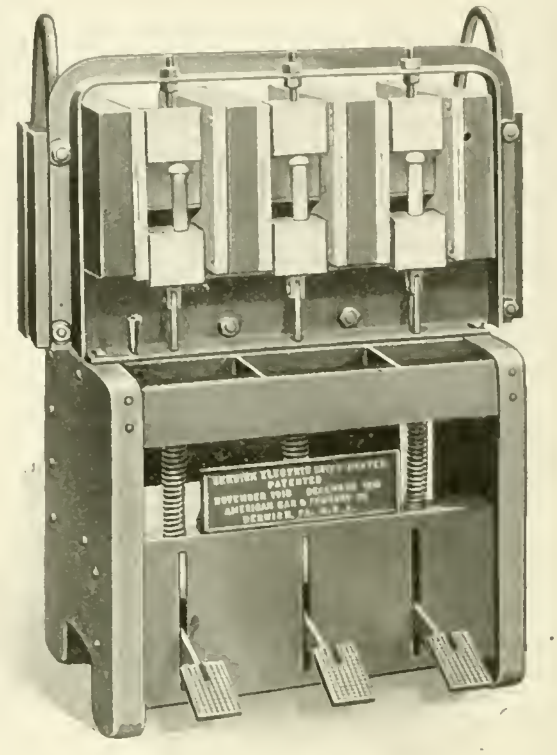
The three machines differ somewhat in details of design, but are similar in principle. They are all of the electric conduction type; the rivets are heated by the passage of an electric current through them. Electrically, the rivet heaters consist of a specially designed transformer. The secondary terminals are heavy copper blocks, between which the rivets to be heated are placed. Suitable means are provided for controlling the current. In the Berwick and Humil machines the rivets being heated are connected in multiple, while in the General Electric machine two rivets are connected in series.



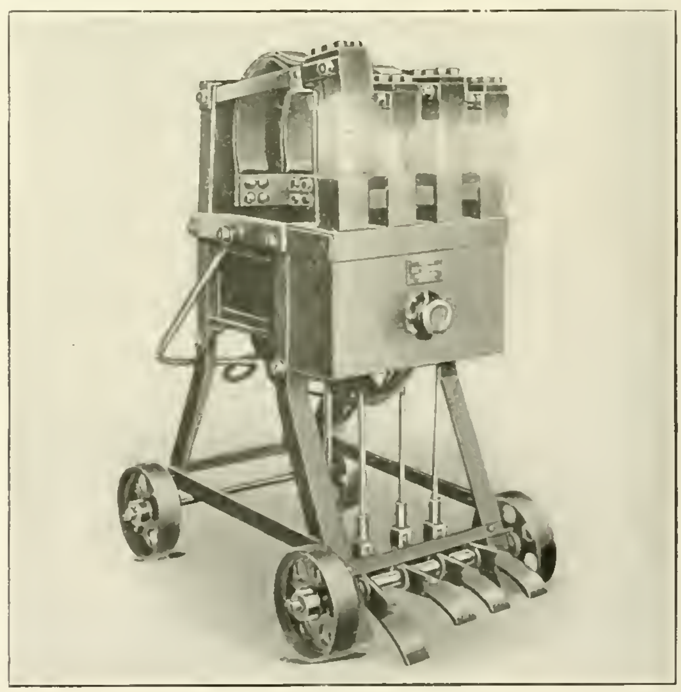
A Two-Head General Electric Rivet Heater

The operation of heating rivets is very simple. The copper blocks which form the secondary terminals are forced apart by a handle or foot treadle, a rivet is placed endwise between the blocks, and on releasing the handle or treadle the blocks are made to grip the rivet by their weight or by springs, depending on the type of machine. A stop prevents the blocks from coming in contact with each other when there is no rivet between them.

The electric furnace is clean, gives off no objectionable gas and the rivets are always in plain view of the operator. The rivet is heated from the inside and the shank becomes hotter than the head, due to its lesser cross section. These are ideal upsetting conditions, as the heat is applied exactly where it is needed, and the head, being cooler, is less malleable and is therefore less likely to be marred by the backing up tool. Rivets can be heated, cooled and reheated a number of times without harmful oxidation and as many as 1,400 rivets can be heated in an hour with a single machine, the hourly capacity depending upon the size of rivet and the number of heating heads on the machine. The machines are built to operate on alternating current supply voltages from 110 to 550; but there is no danger to the operator, as the voltage across the secondary terminals of any of the machines is never more than ten volts. From five to seven pounds of rivets can be heated with a power consumption of one kw. hour.



A Three-Head Berwick Rivet Heater



A Four-Head Humil Rivet Heater

Railway Mechanical Engineer

(*Formerly the* RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated*)

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Subscriptions, including the eight daily editions of the Railway Age, published in June, in connection with the annual convention of the American Railroad Association. Section III—Mechanical, payable in advance and postage free: United States, east of the Mississippi river, $3.00 a year; elsewhere, $4.00 a year; Single copy, 20 cents.

WE GUARANTEE, that of this issue 12,800 copies were printed; that of these 12,800 copies 10,092 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 239 were mailed to advertisers, 32 were mailed to employees and correspondents, 1,000 were provided for distribution in Atlantic City during the Convention of the Mechanical Section, American Railroad Association, and 1,417 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 73,950, an average of 12,325 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The shops of the Atlantic Coast Line at Waycross, Ga., were damaged by fire on the night of April 8 to the amount of about $50,000. The fire started in the car repair shops about nine o'clock in the evening and the flames were fought all night. The car shops, and a small blacksmith shop were completely destroyed, together with the combustible portions of 200 box cars. About 500 men were thrown out of work temporarily.

The Board of Railroad Wages and Working Conditions of the United States Railroad Administration was discontinued on April 1. The board since the termination of federal control on March 1, has been engaged solely in completing the tabulation of data relating to railroad wages and working conditions, the collection of which was begun during the period of federal control, and in recommending necessary interpretations involving readjustments chargeable to the director general of railroads for some portion of the period of federal control under the wage orders issued during federal control. This work has now been completed, insofar as the board is concerned. In accordance with Section 311 (c) of the transportation act, all books, papers and documents of the Board of Railroad Wages and Working Conditions will be transferred to the Labor Board created by the transportation act.

A novel method of familiarizing railway men with the manufacture and use of brake beams will be introduced shortly by the Chicago Railway Equipment Company, Chicago, by means of a five-reel film entitled "Brake Beams—Their Manufacture and Use." The film was taken under the supervision of T. A. Le Beau of the Chicago Railway Equipment Company, and traces the developments from the handling of the raw material at the rolling mill until the various parts are assembled into a finished brake beam. Four of the large industrial plants of the country were visited in making the film. It concludes with the brake beam in service showing the damage that results from improperly applied brake beams. It is planned to show the film at various gatherings of railroad executives, at railroad conventions and to groups of workmen, after which it will be sent abroad.

The director of sales of the War Department has sold the remaining 113 of the 200 Decapod locomotives originally built for the Russian government to Cuthell, White, Bayles and Appel, counsellors at law, Washington, for export, under a condition that the locomotives will not be resold to the Russian soviet republic. They will be repaired, altered to 5-ft. gage, be equipped with Russian couplers and boxed for ocean shipment by the Baldwin Locomotive Works. The purchasers are still negotiating for their disposition. The price was $47,710. The 87 locomotives sold to American railroads were sold at $25,000 in consideration of their inaptitude for service on roads in this country and in order to make their purchase as attractive as possible to American railroads to which the entire lot was originally offered. The War Department has also received bids on about 7,500 freight cars, built for military service in France.

New Devices in May Issue

The locomotive recording instrument described on page 306 of the May *Railway Mechanical Engineer* is made by the Speedograph Corporation, Newark, N. J. The relieving attachment described on page 309 of the same issue is made by W. B. Jones, Rochester, N. Y.

A Practical Freight Train Loading Method

In the article by R. S. Mounce, published in the *Railway Mechanical Engineer* for May, 1920, a serious error occurred in the first and third formulae on page 271. The formula for train load should have read as follows:

70-ton cars—

$$\text{Train load (tons)} = \frac{P}{R}$$

20-ton cars—

$$\text{Train load (tons)} = \frac{P}{r}$$

Mechanical Section Scholarships

Two of the four scholarships at Stevens Institute of Technology, which the Mechanical Section of the American Railroad Association offers to sons of members of the section, will be vacant in June. These scholarships cover the regular tuition charges for a four-year course, leading to the degree of mechanical engineer. The course offered also includes instruction in electrical, civil and other branhes of engi-

neering. Applications should be in the hands of V. R. Hawthorne, secretary, Chicago, not later than June 15. In case there are more than two applicants the scholarships will be given to the two passing the entrance examination with the highest standing. Full information will be supplied by the secretary upon application.

Screw Machine vs. Turret Lathe

The Warner & Swasey Company, Cleveland, Ohio, announces a campaign for discontinuing the name "screw machine" when applied to the modern turret lathe. It is explained that the name "screw machine" is no longer appropriate when applied to the modern turret lathe, which is now seldom used for the making of screws, as automatic screw machines of various types serve this purpose better when large quantities are involved. Ten years ago bar work was the main product handled on what was then known as a hand screw machine; but to-day there is more chucking work performed on the turret lathe than bar work. Furthermore, the modern turret lathe is designed and constructed to handle heavy castings and forgings and is provided with sufficient power for machining tough forgings and alloy steel parts. For use merely for making screws, the present power provided in turret lathes would be superfluous.

The Warner & Swasey Company is urging all users and manufacturers to aid in the campaign for dropping the old term "screw machine" when applied to turret lathes.

English Rolling Stock to Be Standardized

Sir Eric Geddes, Minister of Transport, recently outlined the plans of the Ministry of Transport with regard to standardization on the English railroads. He said that the mechanical engineering department of the Ministry was endeavoring to standardize the freight cars, and a commencement had been made by arranging with all railways and all owners of cars that all running gear should conform to certain standards. With regard to the cars themselves, there is not the least doubt that for certain classes of traffic the object to be aimed at is a car of much higher capacity, for this will lead to a great saving in the weight and length of trains, and consequently in the length of new sidings. Larger cars are not, of course, suitable to all kinds of traffic but for coal traffic they would be of enormous value. In deciding on the size of the car to be used, consideration must be given to existing conditions, to the cost of the alterations to be made in the right of way and structures and what economies would result.

As to the standardization of locomotives, Sir Eric Geddes says this is at present limited by the capacity of bridges and roads already built to carry locomotives of a certain size and therefore at present two or even three classes in each type might be allowed for, say light and heavy, or light, medium and heavy, of which parts could be interchangeable and a considerable reduction effected in the number of types.

The mechanical engineering department is also considering the standardization of signaling apparatus, economies in workshops, improvement in the plant and equipment of docks, and economy in the production and use of everything of a mechanical nature connected with transport.

The Mechanical Conventions

The record-breaking attendance which is expected at the Atlantic City conventions has exhausted the reservations at many of the hotels. J. D. Conway, secretary of the Railway Supply Manufacturers' Association, has offered to be of assistance in the matter of securing accommodations and suggests that those who have not yet secured their reservations might find it of value to communicate with his office at 1841 Oliver building, Pittsburgh.

The Supply Association has arranged to have the Hotel Esplanade which is directly beyond the Chelsea opened for the convention. This hotel does not regularly open until July 1. It has 250 rooms with 60 private baths, running water in all rooms and swimming pool in hotel. American plan rates $6 to $10 a day.

There are many good hotels located off the boardwalk, among which are the Wilshire, Craig Hall and the Grand Atlantic.

For those stopping at hotels located some distance from the pier there is good jitney service on Atlantic avenue, one block from the board-walk, where jitneys run every two or three minutes. The fare is 5 to 10 cents and from the Hotels Esplanade or Breakers to the pier is covered in five minutes.

Calendar for the June Convention

The following is the program for the second annual meeting of the American Railroad Association, Section III—Mechanical, to be held at Atlantic City, June 9 to 16, inclusive:

WEDNESDAY, JUNE 9, 1920

	A.M. A.M.
Prayer	9.30 to 9.40
Address of welcome by mayor of Atlantic City	9.40 to 10.00
Address by the chairman	10.00 to 10.30
Action on minutes of annual meeting of 1919	10.30 to 10.35
Appointment of committee on subjects, resolutions, correspondence, obituaries, etc.	10.35 to 10.45
Unfinished business	10.45 to 10.50
New business	10.50 to 11.00
Report of general committee, including announcement of nominations for members of nominating committee	11.00 to 11.15
Discussion of reports on:	
Nominations	11.15 to 11.30
	M.
Mechanical Stokers	11.30 to 12.00
	M. P.M.
Modernization of Stationary Boiler Plants	12.00 to 12.30

THURSDAY, JUNE 10, 1920

Discussion of reports on:	A.M. A.M.
Fuel Economy and Smoke Prevention	9.30 to 10.00
Auxiliary or Safety Connections Between Engine and Tender	10.00 to 10.30
Design, Maintenance and Operation of Electric Rolling Stock	10.30 to 11.00
Scheduling and Routing Systems for Locomotive Repair Shops	11.00 to 11.30
	M.
Superheater Locomotives	11.30 to 12.00
	M P.M.
Individual paper on "Snow Fighting Apparatus," by W. H. Winterrowd	12.00 to 12.30

FRIDAY, JUNE 11, 1920

Discussion of reports on:	A.M. A.M.
Locomotive Headlights and Classification Lamps	9.30 to 10.00
Feed Water Heaters for Locomotives	10.00 to 10.30
Individual paper on "Locomotives as a Big Investment," by G. M. Basford	10.30 to 11.00
Discussion of reports on:	
Design and Maintenance of Locomotive Boilers	11.00 to 11.30
	M.
Engine Terminals, Design and Operation	11.30 to 12.00
	M. P.M.
Train Resistance and Tonnage Rating	12.00 to 12.30

MONDAY, JUNE 14, 1920

Discussion of reports on:	A.M. A.M.
Autogenous and Electric Welding	9.30 to 10.00
Specifications and Tests for Materials	10.00 to 10.30
Standard and Recommended Practice	10.30 to 10.45
Election of officers	10.45 to 11.00
Discussion of reports on:	
Repair Shop Layouts	11.00 to 11.20
Amalgamation	11.20 to 11.30
Standard Blocking for Cradles of Car Dumping Machines	11.30 to 11.40
	P.M.
Standard Method of Packing Journal Boxes	11.40 to 12.10
	P.M.
Establishment of a Co-operative Research Bureau	12.10 to 12.30

TUESDAY, JUNE 15, 1920

Discussion of reports on:	A.M. A.M.
Revision of Passenger Car Rules of Interchange	9.30 to 10.00
Prices for Labor and Materials	10.00 to 10.30
Depreciation for Freight Cars	10.30 to 11.00
Arbitration	11.00 to 11.30
	M.
Tank Cars	11.30 to 12.00
	M. P.M.
Brake Shoe and Brake Beam Equipment	12.00 to 12.30

WEDNESDAY, JUNE 16, 1920

Discussion of reports on:	A.M. A.M.
Couplers and Draft Gear	9.30 to 9.50
Car Wheels	9.50 to 10.20
Car Construction	10.20 to 10.50
Safety Appliances	10.50 to 10.55
Loading Rules	10.55 to 11.20
Train Brake and Signal Equipment	11.20 to 11.50
	P.M.
Train Lighting and Equipment	11.50 to 12.20
	P.M.
Subjects	12.20 to 12.30

National Screw Thread Commission Report Approved

The progress report of the National Screw Thread Commission, Washington, has been approved by the commission and is now available. The report covers the standardization of only those threads, sizes, types, and systems which are of paramount importance by reason of their extensive use and utility. Information is given to permit the writing of definite and complete specifications for the purchase of screw thread products, and the application of the specifications is explained in detail.

It is recommended by the commission that the United States standard or Sellers' profile, hereafter to be known as the National Form of Thread, be used for all screw thread work except where otherwise specified for special purposes. The coarse thread series recommended are the present United States standard threads supplemented in the sizes below ¼ in. by the standard established by the American Society of Mechanical Engineers. The fine thread series consists of sizes taken from the standards of the Society of Automotive Engineers and the fine thread series of the American Society of Mechanical Engineers.

The report establishes for general use four distinct classes of screw thread fits with subdivisions which, together with specifications, are explained as for the purpose of insuring the interchangeable manufacture of screw thread parts throughout the country. Tolerances are given for loose fit, medium fit (regular and special), and close fit. Extensive tables give the tolerances and dimensions for each class of fit. Tolerances and dimensions are included for fire hose couplings and small hose couplings. A complete gaging system which has been found adequate in the production of war material is specified in detail.

Standard Sizes for Shafting

The Council of the American Society of Mechanical Engineers has approved the report of a committee formed to investigate the standardization of shafting sizes and has accepted the following lists of sizes as recommended standards for the society:

Transmission Shafting:

15/16 in.; 1-3/16 in.; 1-7/16 in.; 1-11/16 in.; 1-15/16 in.; 2-3/16 in.; 2-7/16 in.; 2-15/16 in.; 3-7/16 in.; 3-15/16 in.; 4-7/16 in.; 4-15/16 in.; 5-7/16 in.; and 5-15/16 in.

Machinery Shafting:

Size intervals extending to 2½ in., by sixteenth inches; from 2½ in. to 4 in., inclusive, by eighth inches; from 4 in. to 6 in., by quarter inches.

These standard sizes have also been approved by representatives of the following associations: American Hardware Manufacturers' Association, American Railway Engineering Association, American Supply & Machinery Manufacturers' Association, National Association of Manufacturers of the U. S. A., National Association of Purchasing Agents, National Machine Tool Builders' Association, Southern Supply & Machinery Dealers' Association.

It was the opinion of the committee that the adoption of standard sizes of shafting will mean that in the future there will be a gradual elimination of odd sizes from makers' lists and from dealers' stocks, and for new construction only standard sizes would be selected.

MEETINGS AND CONVENTIONS

Association of Railway Electrical Engineers.—The semiannual meeting of this association will be held at the Hotel Dennis, Atlantic City, on June 14. The meeting will be called to order at 9 a. m. Progress reports will be presented by committees on truck and tractors; electric welding; illumination; train lighting equipment and practice; railway stationary power plants; electric headlights; electrification; electric repair shop facilities and equipment.

American Railroad Master Tinners', Coppersmiths' & Pipefitters' Association.—At the convention of this association, which will be held June 1-4 at the Hotel Sherman, Chicago, the following subjects will be discussed: Headlights and their maintenance, locomotive jackets, manufacturing in locomotive tin shops, steam heat and its upkeep, acetylene welding in the tin shop, spot welding in the tin shop, repairs to steel coaches, methods of babbitting, reclamation of scrap sheet metal, air brake piping.

American Society for Testing Materials.—This society will hold its twenty-third annual meeting at Asbury Park, N. J., on June 22 to 25 inclusive, with headquarters at the New Monterey hotel. The first session will be held at 10 a. m., Tuesday, June 22. Papers and reports will be presented at the various sessions in accordance with the following general outline:

Tuesday morning	Non-Ferrous Metals.
Tuesday afternoon	Wrought and Malleable Iron and Corrosion.
Tuesday evening	Presidential address and reports of administrative committees.
Wednesday morning	Steel.
Wednesday afternoon	Committee meetings.
Wednesday evening	Testing Apparatus.
Thursday morning	Preservative Coatings and Lubricants.
Thursday afternoon	Miscellaneous Committee Reports and Papers.
Thursday evening	Ceramics.
Friday morning	Road, Materials, Lime and Gypsum.
Friday afternoon	Golf tournament
Friday evening	Cement and Concrete.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Convention, June 9-16, 1920, Atlantic City, N. J.

American Railroad Association, Section VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Convention June 14-16, 1920, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. B. Baker, Terminal Railroad, St. Louis, Mo. Convention June 1-4, 1920, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meetings second Tuesday in month, except June, July and August.

Car Foremen's Association of Chicago.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Friday in January, March, May and September and second Thursday in November, Hotel Statler, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention Sept. 7-10, 1920, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meetings second Tuesday in month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Meetings third Friday in month, except June, July and August, 29 W. 39th St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings, second Thursday in month, alternately in San Francisco and Oakland.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings, fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Meetings, second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

Western Railway Club.—J. M. Byrne, 916 West 78th St., Chicago. Meetings, third Monday in month, except June, July and August.

PERSONAL MENTION

GENERAL

A. S. Abbott has resigned as superviser of tools of the St. Louis-San Francisco, at Springfield, Mo., to become superintendent of motive power of the Miami Mineral Belt at Miami, Okla.

George S. Edmonds, recently appointed acting superintendent motive power of the Delaware & Hudson, with headquarters at Colonie, N. Y., has been appointed superintendent motive power, succeeding James H. Manning, deceased. Mr. Edmonds was graduated from Cornell University in 1895. He began railroad work shortly after graduation, in the shops of the New York Central and afterwards served in the road and mechanical engineer's office. He went to the Delaware & Hudson in 1900 as mechanical engineer and was appointed master mechanic in 1905, retaining that position until 1912 when he was appointed shop superintendent. On April 5, 1920, he became acting superintendent motive power and was promoted to superintendent motive power on April 21.

Ernest V. Williams, shop superintendent of the Buffalo, Rochester & Pittsburgh, has been appointed superintendent motive power with headquarters at DuBois, Pa., succeeding F. J. Harrison, deceased. Mr. Williams served as apprentice at the Brooks Locomotive Works, Dunkirk, N. Y., and afterwards worked as machinist for the Rome Locomotive Works, Rome, N. Y., prior to beginning railroad work. He then entered the employ of the New York Central as machinist at West Albany, N. Y. Shortly afterwards he was promoted to assistant machine shop foreman at the same place and then to assistant to the superintendent of shops. His next position was that of machine shop foreman, also at West Albany. Later he was transferred to Depew, N. Y., as assistant general foreman, but afterwards he returned to West Albany as general foreman. He went to the Buffalo, Rochester & Pittsburgh on June 1, 1917, to accept an appointment as shop superintendent, the position he filled at the time of his recent promotion.

E. V. Williams

Walker D. Hines has resigned as director general of railroads, effective May 15, and after a vacation trip abroad he plans to resume the practice of law in New York city. John Barton Payne, Secretary of the Interior, has been appointed to succeed Mr. Hines as director general, to have charge of the liquidation of the Railroad Administration and to act as the agent designated in Section 206 of the Transportation Act. In accepting Mr. Hines' resignation the President wrote that he could not let the director general retire without telling him how he had "personally valued and admired the quite unusual services you have rendered the government and the country." Mr. Hines has been connected with the Railroad Administration since its organization. He was first appointed assistant to the director general and later, when Mr. McAdoo left Washington for an extended trip, he was appointed assistant director general and left in direct charge of the organization at Washington. He was appointed director general to succeed Mr. McAdoo on January 11, 1919. Prior to federal control he was chairman of the board of the Atchison, Topeka & Santa Fe and a member of the law firm of Cravat, Henderson & de Gersdorff.

John M. Kincaid, electrician foreman of the Erie at Hornell, N. Y., has been appointed electrical supervisor for the Hornell region, with office at Hornell.

F. P. Pfahler, who has been chief mechanical engineer of the Railroad Administration with office at Washington, D. C., has returned to the service of the Baltimore & Ohio as supervisor of locomotive maintenance, with office at Baltimore, and also the mechanical member of a committee appointed to investigate the feasibility of electrifying one or two of its divisions.

F. W. Rhuark has been appointed mechanical superintendent of the Pittsburgh & West Virginia. Mr. Rhuark was formerly master mechanic of the Baltimore & Ohio, eastern lines with headquarters at Connellsville, Pa.

Edward A. Sweeley, a member of Railway Board of Adjustment No. 2, of the Railroad Administration, has resigned to become mechanical superintendent of the Fruit Growers' Express.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

E. Bowie has been appointed division master mechanic of the Brownville division of the Canadian Pacific, with headquarters at Brownville Junction, Me., succeeeding W. Wright, transferred.

Harry L. Gettys has been appointed master mechanic of the Virginian, with headquarters at Roanoke, Va. He was born on June 16, 1876, at New Hope, Pa., and was graduated from Roanoke High School in 1892. On October 1 of that year he began railroad work in the boiler department of the Norfolk Western and afterwards served a machinist apprenticeship. During the Spanish-American war he enlisted in the United States Navy and afterwards until August, 1905, was in the employ of the government at the Washington Navy yard. He then returned to the Norfolk & Western and was appointed rod gang foreman in 1907, assistant general foreman at West Roanoke in 1908, and from 1909 to 1913 did special work in connection with the cost of handling locomotives. He was then appointed chief inspector of new locomotive construction with the title of mechanical inspector, remaining in that position until 1917. On February 1, 1918, he entered the employ of the Nathan Manufacturing Company, but on March 15, 1920, accepted his present position as master mechanic of the Virginian at Roanoke.

J. E. Goodman, who was granted leave of absence a few months ago, has resumed his duties as master mechanic of the Lake Superior division of the Northern Pacific with headquarters at Duluth, Minn. and John A. Marshall, who served as acting master mechanic during Mr. Goodman's absence, has resumed his position as road foreman of engines at Duluth.

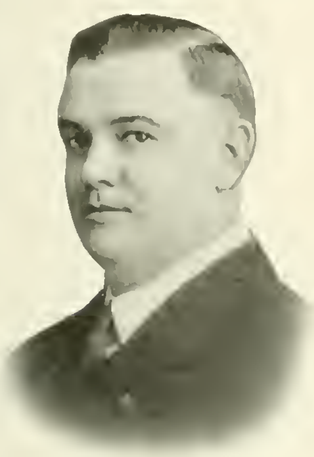
A. Hambleton, general foreman of the Chicago, Rock Island & Pacific shops at Shawnee, Okla., has been appointed master mechanic at Eldorado, Ark., succeeding W. M. Wilson, resigned to accept service with the Locomotive Firebox Company, Chicago.

C. E. McMillen has been appointed road foreman of engines on the Eastern division of the Atchison, Topeka & Santa Fe, with headquarters at Argentine, Kan.

J. K. Nimmo, assistant general boiler inspector of the Western district, Eastern lines, Atchison, Topeka & Santa Fe, has been appointed acting master mechanic of the Oklahoma division, with headquarters at Arkansas City, Kan., succeeding W. J. Hill, assigned to other duties.

Vern C. Randolph has been appointed general supervisor of locomotive operation for the Hornell region of the Erie, with headquarters at Hornell, N. Y.

George W. Rankin, formerly assistant master mechanic of the Louisville terminal of the Louisville & Nashville, has been appointed assistant master mechanic at the South Louisville shops of the same road. Mr. Rankin is 32 years old and was born in Pennsylvania. He received his education in the Louisville, Ky., schools, and is a graduate of the manual training high school of that city. He served an apprenticeship in the shops of the Louisville & Nashville, which he completed in 1909 and was subsequently promoted to the position of foreman. He acted in that capacity until 1917, when he was appointed assistant master mechanic of the Louisville terminal, and on March 1, 1920, received his present appointment.



G. W. Rankin

A. R. Teague has been appointed master mechanic of the Mobile division of the Mobile & Ohio at Whistler, Ala., succeeding G. L. Lambeth.

Fred L. Voerge has been appointed assistant master mechanic of the Montana division of the Northern Pacific, with headquarters at Livingston, Mont.

W. Wright has been appointed division master mechanic of the Farnham division of the Canadian Pacific, with headquarters at Farnham, Que., succeeding R. Walton, transferred.

CAR DEPARTMENT

Glenn A. Allen, supervisor of locomotive operation of the Erie at Susquehanna, Pa., has been appointed supervisor of air brakes, with headquarters at Hornell, N. Y.

John F. Sommers has been appointed supervisor of car repairs of the Erie, at Hornell, N. Y.

SHOP AND ENGINEHOUSE

H. G. Becker, general foreman of the Delaware & Hudson at Colonie, N. Y., has been appointed shop superintendent to succeed G. S. Edmonds.

George Goldsmith has been appointed shop superintendent of the Erie at Buffalo, N. Y.

Humphries W. Brewer, general foreman of the Buffalo, Rochester & Pittsburgh, at DuBois, Pa., has been appointed superintendent of shops at that point, succeeding E. V. Williams. Mr. Brewer was born on December 19, 1881, at Corning, N. Y., where he attended the public schools. On October 12, 1898, he began a machinist apprenticeship with the Fall Brook Railroad at Corning, which he completed after this road was merged with the New York Central. He was then transferred to the Avis shops of the latter road as a mechanic, later being promoted to foreman. Subsequently he went to West Albany and acted as foreman there until July, 1917, when he resigned to accept the position of general foreman of the Buffalo, Rochester & Pittsburgh at DuBois, which he held until he received his recent appointment.

PURCHASING AND STOREKEEPING

G. W. Bichlmeir has been appointed purchasing agent of the Kansas City Southern, with office at Kansas City, Mo., succeeding W. S. Atkinson, resigned.

D. C. Curtis, prior to federal control inspector of stores on the Chicago, Burlington & Quincy, and during federal control storekeeper for the Northwestern Regional Purchasing Committee, has been appointed general storekeeper of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee shops, Wis., succeeding F. J. O'Connor, who has been assigned to other duties.

W. J. Diehl, general storekeeper of the Mobile & Ohio, with headquarters at Mobile, Ala., has been appointed purchasing agent, with the same headquarters, succeeding J. A. Turner, resigned. The office of general storekeeper has been abolished.

G. W. Leigh, assistant general storekeeper on the Minneapolis, St. Paul & Sault Ste. Marie, at Minneapolis, Minn., has been appointed general storekeeper, with the same headquarters, succeeding T. W. Flannagan, promoted.

W. A. Summerhays, assistant purchasing agent of the Illinois Central, with headquarters at Chicago, has been appointed purchasing agent, with the same headquarters.

E. W. Thornley, formerly supervisor of stores, United States Railroad Administration, has been appointed assistant purchasing agent of the Baltimore & Ohio, with headquarters at Baltimore, Md.

OBITUARY

Charles F. Jacobson, motive power inspector for the New York Central Lines in the fourth inspection district, with headquarters at Elkhart, Ind., died at his home in Elkhart on March 25.

George H. Gilman, master car builder of the Northern Pacific, with headquarters at St. Paul, Minn., died on February 27 after a short illness. Mr. Gilman was born at McArthur, Ohio, on April 11, 1862. He began railroad work as a car carpenter on the Northern Pacific when 22 years old. In October, 1884, shortly after entering the employ of that road, he was promoted to car foreman. While serving in that capacity he was transferred several times to different places. He was appointed shop superintendent and master car builder at the Como shops in 1903, and on November 26, 1905, his title was changed to master car builder.

Thomas J. Burns, superintendent rolling stock of the Michigan Central, with headquarters at Detroit, Mich., died in that city on April 18. Mr. Burns was born at Hillsdale, Mich., on July 24, 1868. He graduated from Assumption College and spent some years at Grand Seminary, Montreal. His first railroad work was as clerk in the maintenance of way department of the Michigan Central at Bay City, Mich. He became engine despatcher on November 1, 1896, and was appointed chief clerk to the master mechanic at Jackson, Mich., on December 15, 1902. In August, 1905, he was transferred to Detroit, Mich., as chief clerk to the superintendent motive power, and was appointed assistant superintendent motive power on June 1, 1912. In 1915 he was appointed to the position he held at the time of his death.

SUPPLY TRADE NOTES

The Grip Nut Company, Chicago, has opened a new plant at 5917 Western avenue, Chicago.

Arthur Benedict Bellows, first vice-president of the Pittsburgh Testing Laboratory, Pittsburgh, Pa., died on April 17.

The United States Gauge Company has moved its general sales office from 67 Wall street, to 37-39 Liberty street, New York.

Roger C. Sullivan, chairman of the board of directors of the Independent Pneumatic Tool Company, Chicago, died on April 14.

A. C. Moore has been appointed assistant to the president of the Globe Seamless Steel Tubes Company, Chicago, with headquarters at Chicago.

The Jerome-Edwards Metallic Packing Company, Chicago, Ill., recently removed to its new factory at 3136-3138 W. Chicago avenue, Chicago.

The Independent Pneumatic Tool Company, Chicago, has removed its Detroit, Mich., offices from 736 David Whitney building, to larger quarters at 55 Garfield building.

G. B. Albright, has been appointed manager of the railway department for the western district, of the Lowe Brothers Company, Dayton, Ohio, with headquarters at Chicago.

Daniel Cram Noble, president and treasurer of the Pittsburgh Spring & Steel Company, Pittsburgh, Pa., died at his home in that city on May 8, at the age of 75. He was born in Baldwin, Me., on August 5, 1845, and was educated at Hebron Academy, Maine. For more than 25 years Mr. Noble was identified with branch lines of the Pennsylvania Railroad. He went to Pittsburgh in 1868, and in 1880 became associated with the A. French Spring Company of that city, remaining with that company until 1902, when he founded the Pittsburgh Spring & Steel Company. At the time of his death Mr. Noble was a director of a number of banks and insurance companies of Pittsburgh.

D. C. Noble

On April 26 the New York office of the Electric Storage Battery Company was moved from 100 Broadway to the National Association building, 23-31 West Forty-third street.

B. H. Forsyth, salesman for the Grip Nut Company, Chicago, has been appointed manager of the Pittsburgh office of the Chisholm-Moore Manufacturing Company, Cleveland, Ohio.

John Wesley Hyatt, inventor of the Hyatt roller bearing, died on May 10, at his home in Short Hills, N. J., at the age of 83. Mr. Hyatt was not connected with the Hyatt Roller Bearing Company, having sold the patent for this invention about 25 years ago.

George F. Griffin, son of the late Thomas A. Griffin, founder of the Griffin Wheel Company, and a director of that company, died on May 4 at Miami, Fla., at the age of 39 years.

A. B. Burgess, sales manager of the Powell Machine Company, Worcester, Mass., has been appointed eastern representative of the Houghton Elevator & Machine Company, Toledo, Ohio.

On April 30 the New York office of the Sunbeam Electric Company (formerly Schroeder Headlight & Generator Company), Evansville, Ind., was moved from 50 Church street to 52 Vanderbilt avenue, New York.

Frank P. Roesch has been appointed western manager of the Standard Stoker Company, Inc., New York, and has charge of the Chicago office of the company, which was recently opened at 1549 McCormick building, for the purpose of handling the newly developed Du Pont type locomotive stoker. Mr. Roesch was during federal control connected with the United States Railroad Administration as regional fuel supervisor for the Northwestern region and prior to that was employed as master mechanic on the El Paso & Southwestern, the Southern, and the Chicago & Alton. Mr. Roesch is a member of the American Society of Mechanical Engineers and several of the prominent mechanical department associations, and has contributed a number of articles to the columns of the *Railway Mechanical Engineer*.

F. P. Roesch

F. R. Bolles, formerly vice-president and general manager of the Copper Range Railroad, Houghton, Mich., has been appointed vice-president and general manager of the American Automatic Connector Company, Cleveland, Ohio.

J. F. McDonnell, who for the past nine years has been connected with the Dearborn Chemical Company, has been appointed special railroad representative of the packing department, mechanical rubber division of the United States Rubber Company, with headquarters at Chicago.

The officers of the Elvin Mechanical Stoker Company, 23 West Forty-third street, New York, are as follows: Frank H. Clark, president; John R. Given, vice-president; A. G. Elvin, treasurer; Frederick P. Whittaker, secretary; J. Snowden Bell, patent attorney, 149 Broadway, New York.

Carl G. Barth, a pioneer in the machine building industry, has been elected an honorary member of the Taylor Society, New York, which was organized for the promotion of science in management. Since 1899 Mr. Barth has been associated with Frederick W. Taylor at Bethlehem, Pa., conducting experimental work on the fundamental formulas in cutting metals.

J. W. Austin has been elected a member of the Detroit Graphite Company, Detroit, Mich., with the title of assistant secretary. He is well known throughout the paint and varnish industry, having been for 20 years with the Acme White Lead & Color Works, during the past 15 years as general purchasing agent of that company. In addition to other du-

ties in the Detroit Graphite Company, Mr. Austin will direct the purchasing policy for both its Detroit and allied Canadian plants.

The partnership lately existing between L. H. Turner, Jr., and L. W. Garratt, under the name of L. H. Turner, Jr., & Co., dealers in railway equipment, having been terminated by the recent death of Mr. Turner, the business will henceforth be conducted by Mr. Garratt as its sole proprietor, under the name of L. W. Garratt, 358 Union Arcade, Pittsburgh, Pa.

Frank C. Smink, formerly for 17 years president of the Reading Iron Company, Reading, Pa., died on March 3, of a complication of diseases, at his home in Reading, at the age of 74. After an early training with the Philadelphia & Reading Railway Company and in Reading banking circles, Mr. Smink, in 1878, entered the service of the Reading Iron Works, as business manager. He remained in that position until the organization of the Reading Iron Company in 1889, when he was made treasurer, and subsequently served as vice-president and general manager under the presidency of the late George F. Baer, whom he succeeded in 1902. Mr. Smink was a director of the Reading Trust Company, also the Temple Iron Company, and for many years served as a member of the executive committee and a director of the Pennsylvania Steel Company, the Spanish-American Iron Company, the Maryland Steel Company, the Penn-Mary Coal Company, the Pure Oil Company, and other organizations.

F. C. Smink

In the issue of March, 1920, an erroneous statement appeared regarding arrangements which the Cincinnati Shaper Company was making for the handling of its foreign business. A representative of the company has gone abroad to demonstrate its machines in various plants on the Continent, but no change is to be made in its present foreign agency connections. The president of the company is P. G. March.

George A. Price has been elected treasurer of the American Arch Company, 30 Church street, New York. Mr. Price started work on the New York Central & Hudson River in the motive power department, at the DeWitt enginehouse, and from there was transferred to the office of the superintendent of motive power of the New York Central. In August, 1912, he resigned to enter the service of the American Arch Company. On March 1, 1918, he was elected assistant secretary, and he has now been elected treasurer. In addition to being treasurer Mr. Price will also continue his duties as assistant secretary.

Fred T. Ley, formerly president of the Napier Saw Works, Inc., Springfield, Mass., is the president of a new company organized to take over the band saw and band saw machine business of the Napier Saw Works, Inc. The new company will be known as the Metal Saw & Machine Company, Inc., Springfield, Mass. Mr. Ley will have associated with him as treasurer and general manager, Henry M. Blanchard. The schedule for the present year calls for a production of several hundred machines and it is anticipated that as many as 2,000 machines will be turned out in 1921.

Peter P. Beck, dealer in railway and manufacturers' supplies, removed his office and showroom on May 1, from 105-107 Chambers street, New York, to 22 Thames street. Mr. Beck is sales agent at New York for the Bettendorf Company, Bettendorf, Iowa; Wine Railway Appliance Company, Toledo, Ohio; Railway Brake Specialties Company, Toledo, Ohio; Slick-Knox Steel Company, Sharon, Pa.; Sturdi-Truck Manufacturing Company, Holyoke, Mass.; Liberty Tool Corporation, Baltimore, Md.; Howe Waste & Packing Company, Providence, R. I.; Wm. A. Tottle & Company, Baltimore, Md.; and the Nu-ex Fire Appliance Company, Columbus, Ohio.

The Victor Saw Works, Springfield, Mass., has been purchased by New York banking interests and new officers elected as follows: President, Winthrop Sargeant, Jr.; vice-president and general manager in charge of operation, George J. Siedler; treasurer, Louis J. Oswale; secretary, William P. Jeffery. W. F. Pollock will remain with the company as assistant manager. The Napier Saw Works, Springfield, Mass., has also been acquired by the same interests, the purchase taking in the hack saw blade business, good will and equipment, but not the plant. The old owners of the Napier works retain the factory and the band saw and band saw machine end of that business.

Harry U. Morton, whose appointment as president and treasurer of the Dunbar Manufacturing Company, Chicago, was announced in the May issue, was born on April 25, 1866, in Painesville, Ohio. He entered railway service in 1891 with the Pullman Company, remaining with that company for 17 years of which he served four years in the manufacturing department and 13 years in the operating department. In 1907 he was appointed vice-president and general manager of the General Railway Supply Company. Seven years later he was appointed vice-president and secretary of the Acme Supply Company, Chicago, the corporate name of this company being changed in 1917 to the Dunbar Manufacturing Company. On April 1 of this year he was elected president and treasurer of the latter company succeeding Thomas Dunbar, who has resigned.

H. U. Morton

The Westinghouse Union Battery Company was recently organized in Pittsburgh, Pa., to produce storage batteries for every industry in which batteries are used. The company will specialize in starting and lighting batteries for renewal in automobiles, although the complete line will include batteries for trucks, tractors, motor boats and airplanes; also for home lighting systems, train lighting and railway signals. A. L. Humphrey, president of the Westinghouse Air Brake Company, and active in the management of all of its subsidiary organizations, is chairman of the board of directors of the new company. D. F. Crawford, vice-president and general manager of the Locomotive Stoker Company, is president of the new company, and T. R. Cook, formerly chief engineer and general production manager of the Willard Storage Battery Company, is vice-president and general manager. T. S. Grubbs, vice-president of the Union Switch &

Signal Company, is also vice-president and secretary and treasurer of the new organization.

The Carborundum Company, Niagara Falls, N. Y., is carrying out improvements at a cost of about $500,000, extending and improving its plant at Niagara Falls and its two furnace plants, one at Niagara Falls, Ont., and the other at Shawinigan Falls, Que. A three-story addition to the paper and cloth plant at Niagara Falls has just been finished; it is 432 ft. long and 81 ft. wide and will provide greater facilities for the storing and curing of all carborundum, Garnet and Aloxite paper and cloth products and for the extension of the rubber bonded wheel department. Another addition, just completed, extends one of the wheel-making and kiln departments, the new building being two stories high, 96 ft. long and 64 ft. wide. Both of these new structures are of concrete and are of the most modern type. Other extensions and improvements have been planned and work will be started immediately. These call for additions to the crushing departments and other improvements at the furnace plant at Niagara Falls, Ont., where the abrasive Aloxite is made, and at Shawinigan Falls, Que., where is located an extensive carborundum furnace plant. Besides these buildings the program calls for the extension of at least 14 different departments at the Niagara Falls, N. Y., plant.

This company has also acquired the plant formerly operated by the Didier-March Company at Perth Amboy, N. J., where it will manufacture a complete line of carborundum refractories. The plant is located on a site of 24 acres and consists of a modern clay working and refractory plant with a capacity of about 100 tons a day, covering a floor space of about 300,000 sq. ft. In addition to this property the Carborundum company has purchased 60 acres of high grade fire clay lands at Bonhamton and a clay excavating plant.

J. J. Thomas, Jr., formerly superintendent of motive power and car equipment of the Mobile & Ohio, at Mobile, Ala., has been appointed district manager of the Oxweld Railroad Service Company, Chicago, with headquarters at Mobile. Mr. Thomas entered railway service in 1881 as a fireman on the Selma, Rome & Dalton, now part of the Southern, later becoming a machinist apprentice on the same road. From 1885 to 1898 he was successively locomotive engineer, machine shop foreman general foreman and master mechanic on the Birmingham & Atlantic. In 1898 he was appointed master mechanic on the Mobile & Ohio, with headquarters at Tuscaloosa, Ala., and was later promoted to assistant superintendent of motive power and car equipment, with headquarters at Mobile. In 1902 he was appointed master mechanic of the Seaboard Air Line, with headquarters at Savannah, Ga., resigning some time later to become master mechanic on the Atlantic Coast Line, with headquarters at South Rocky Mount, N. C. He was appointed superintendent of motive power and car equipment on the Mobile & Ohio in 1909, which position he held until the time of his appointment as district manager for the Oxweld Railroad Service Company.


J. J. Thomas, Jr.

TRADE PUBLICATIONS

Tructractor.—The Clark Tructractor Company, Chicago, has issued a pamphlet showing photographs and specifications of all models of the Clark Tructractor, with illustrations showing it at work in various industrial plants.

Tool Steel.—A brief discussion of the question whether chemical analyses are of greater importance in the quality of tool steel than its careful manufacture in all processes, is printed in a pamphlet of eight pages published by the Vanadium-Alloys Steel Company, Pittsburgh, Pa.

Pneumatic Brake Equipment.—The Westinghouse Air Brake Company, Pittsburgh, Pa., has issued catalogue 2021, which briefly describes and illustrates the standardized UC Westinghouse brake equipment for steam road passenger trains, which, with simple electric attachments, is said to represent the most improved form of electro-pneumatic train brake for both electric and steam road passenger trains.

Cowan Transveyor.—A booklet of 28 pages, entitled Transveyor Picture Book, is being distributed by the Cowan Truck Company, Holyoke, Mass. It shows by means of illustrations the work that these transveyors are doing in a great variety of industries where they are being used. It also points out the advantages of their construction and contains specifications for all types.

Arch Tube Cleaners.—A revised catalogue of locomotive arch tube cleaners (W-4) has been issued by the Lagonda Manufacturing Company, Springfield, Ohio. The catalogue goes into the subject of arch tube cleaning and describes the different types of standard cleaners made by this company, giving a description of their general construction and usage. It also illustrates repair parts and covers briefly several other products.

Ingot Iron Wire.—The Page Steel & Wire Company, New York, has published a complete pamphlet describing fully the electrical and physical properties of American ingot iron wire. This is the first complete publication of this data and the result of many tests made during the past two years under the supervision of the Electrical Testing Laboratory, New York, and Frank F. Fowle, consulting electrical engineer for this company.

Portable Machine Tools.—The Pedrick Tool & Machine Company, Philadelphia, Pa., has issued a comprehensive, well-illustrated catalogue of 96 pages, describing the special machine tools manufactured by the company for use in railway shops, shipyards and general machine shops. Among the tools of special interest to railroad men may be mentioned the portable cylinder boring bar, column boring bar, duplex horizontal boring machine, portable crank pin-turning machine, locomotive pedestal jaw facer and pipe-bending machine.

Tank Car Center Sills.—The Pennsylvania Tank Car Company, Sharon, Pa., describes its type A-1 center sill in a booklet entitled "One Reason Why Pennsylvania Tank Cars Are Used by Leaders of Industry." Although the booklet briefly describes the construction of the sill, it deals principally with tests conducted by Professor Endsley of the University of Pittsburgh at the testing laboratory of the Union Draft Gear Company in December, 1918, to determine the relative strength of the type A-1 center sill, which is patented and used exclusively by the Pennsylvania Tank Car Company, and the type A center sill, now in general use. The booklet contains a number of illustrations.

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Preparedness in Engine Terminals

A good deal more could be said in favor of modernizing engine terminals than will be found in the article on Modern Versus Obsolete Engine Terminals appearing in this issue. The difficulty of operating an out-of-date engine terminal where only heavy locomotives are handled makes it a tremendous task to keep the power moving through the terminal, and the effect on the morale of shop employees that would be obtained through improving these facilities would in itself justify a considerable expenditure towards improvement.

Engine terminals might be styled the front line trenches. Without proper facilities, the day on which the power will break through these front line trenches and the locomotives descend upon the back shop will inevitably be advanced. If these terminals have modern roundhouses with adequate machine shop equipment, boiler washing plants and efficient coal and ash handling layouts, the equipment will certainly be kept in action for a much longer period, and when the break comes it will be an orderly retreat that will not tax the resources of the back shop to the limit. This simple analogy between the terminal and the trenches should be taken to heart by those who are interested in having our railroads make good.

Engine terminals should not only be modernized, but must be kept up to date. The strain on any terminal increases even more rapidly than the capacity of motive power handled, and since we must look for further increases in this direction, preparedness in engine terminals requires that these terminals be built for the future, and that there be room for additional buildings when these are needed. How often has it been necessary to change the location of an entire terminal in order to get the needed space for additional structures? It is not safe to assume that locomotives have attained their maximum capacity and that economy devices have reached the limit. It has been stated that the steel industry must double its capacity every ten years to keep abreast of this country's requirements. How long can you meet the growing requirements of your railroad with congested, poorly planned and inadequately equipped engine terminals; what is it costing your company to handle locomotives with antiquated facilities?

A. R. A. (Section III) Discusses Car Wheel Grinding

Several times recently, reference has been made in the columns of the *Railway Mechanical Engineer* to the possibilities of economy by grinding car wheels. That the subject is a pertinent and important one is indicated by the animated discussion of car wheel grinding which followed the presentation of the report of the Committee on Car Wheels at the recent convention of the American Railroad Association, Section III, at Atlantic City. C. T. Ripley, general mechanical inspector of the Atchison, Topeka & Santa Fe, called attention to the practice of reclaiming slid flat cast iron car wheels by grinding. He stated that the work has been going on for approximately ten years on the Santa Fe with important savings; no objections to the practice had developed. Cars ride smoother, there is less wear and tear on equipment and once a wheel is ground smooth, round and concentric with the journal, there is less tendency for it to slide again.

The question was raised by C. E. Fuller, superintendent of motive power of the Union Pacific, as to the depth of chill in cast iron wheels and whether there was danger of grinding through it. The consensus of opinion was that no danger of grinding through the chill existed, since it was at

least ½ in. thick; and if the chill was almost worn through, the wheel would have to be scrapped, anyway, for flange wear. Some of the members considered it dangerous practice to grind out flat spots, due to the punishment the wheel had received in sliding and the consequent danger of the wheel bursting. The answer to this argument was that badly brake burned wheels were not reground and that those with small checks were not appreciably weakened.

It developed that before the war the cost of grinding car wheels on the Santa Fe was $.53 per pair, including all overhead, interest and depreciation charges. Mr. Ripley stated that the cost is now around $1.00 per pair. In this connection, it is interesting to note that the estimated cost given in a car wheel grinding article on page 355 of the June issue of the *Railway Mechanical Engineer* is $1.50 per pair. Even this estimate of cost allows a total saving of $6.05 per pair, which is large enough to warrant the installation of a car wheel grinding machine in any shop where enough slid flat wheels are received to keep the machine busy a fair proportion of the time.

Discussion of the report also developed the fact that some roads take light truing cuts on steel wheels to remove any eccentricities in the wheels themselves or due to mounting. New chilled cast iron wheels are being ground by a large eastern road to accomplish this purpose and it seems probable that, where only a light cut is to be taken, a grinding machine will perform the operation more quickly and with less waste of material than a lathe. Certainly the ability to remove steel by grinding need not to be questioned, since powerful car wheel grinding machines are now used by manufacturers to grind the tough manganese treads of steel car wheels. The importance of the subject would seem to justify especial consideration by the Committee on Car Wheels to determine what limitations there are to car wheel grinding and to adopt recommended practices for the guidance of the roads.

Modernized Stationary Boilers

One of the most difficult problems with which the mechanical department has to contend is that of inadequate power plant capacity. The stationary boiler plant upon which the shop or roundhouse is dependent is one of the most vital spots on the railroad and unquestionably there are a very large number of outgrown, overburdened boiler installations in operation on the railroads today. The problem of increasing the efficiency and capacity of these boilers is an important and difficult one in view of the cost of installing additional boilers, which involves additional space, added foundations and setting, new boiler room construction and, finally, the boiler itself. One way in which this situation can often be improved without involving all the expense incident to the installation of new boilers is to increase the efficiency and capacity of the stationary boilers that are now in service. With all that has been said recently in favor of modernizing locomotives it is surprising that the opportunity for modernizing stationary boilers has not been given more general attention. The application of the superheater to stationary boilers would seem to offer advantages comparable with the results obtained in locomotive service. A good exposition of the improvement that can be effected through modernizing stationary boilers in railroad service will be found in an article contributed to this issue by the assistant engineer of an eastern railroad. The advantage of having ample steam pressure for the generator sets, plenty of air for the shops and good dry steam for the steam hammer is obvious; the problem is to secure the desired results with the means available. Modernizing your stationary boilers may prove a practical means.

Evolution of the Car Roof

The average roof is one of the details about a freight car that leaves much to be desired, though there are undoubtedly many specific instances of roofs that are giving eminently satisfactory service. The suggestion that the car roof is still in the process of evolution and the prediction that the ultimate roof will be rigid and of all-steel construction, comprising ⅛-in. sheets or heavier, is interesting. This suggestion and the prophecy come from a representative of the car department of the largest Canadian railroad, who is the author of a very comprehensive review of the development of the car roof recently presented before the Canadian Railway Club and abstracted in another column of this issue. The information that shingles were employed in early car roof construction is interesting in the light of subsequent developments in car roofs, as outlined in the article referred to. Not only the development, but the motive behind this development and the obstacles that have been encountered and that confront roof construction today, are plainly stated in this article. It is clearly the duty of the car department to give the car roof more attention. As is pointed out, the position of the car roof in relation to other parts of the car does not easily lend itself to proper maintenance. Other parts are constantly being inspected for defects, but roof failure is seldom observed until the damage has actually occurred. As in the famous shingling episode, the need for roof maintenance in fair weather is not apparent and in wet weather it is too late to be attended to.

The Status of Autogenous Welding

There is a growing belief that autogenous welding has its limitations. The early enthusiasm with which the process was accepted by the railroads is suffering a reaction which, no doubt, is the natural outcome of the attempt to make it a panacea for all the ills of wear or failure to which metal parts of railway equipment are heirs. There is, however, grave danger that the reaction will carry the railroads as much too far in the direction of conservatism as the early enthusiasm carried them beyond the limits of safety and economy, considering the undeveloped state of the art when it was first brought into the railroad field.

There are three prime essentials to successful autogenous welding. The first is a properly trained and experienced operator; the second is the proper preparation and laying out of the work; the third is the use of proper welding materials and appliances. The third requirement involves no real difficulty, as proper materials and appliances are available. But in the case of the first two essentials much remains to be done before the full possibilities of the art can be realized. The danger from the standpoint of future development lies not in the establishment of temporary limitations, but in failure to recognize the true nature of the cause which makes them necessary. Machinists, boilermakers, and even barbers, after a few days of special training, are alike frequently considered competent to operate on important work. When the results are not all that should be expected from really competent operators, there seems to be a tendency to attribute the failure of inherent limitations of the process itself. The fact is overlooked that success in welding depends far more on the skill and the integrity of the operator than in the case of any of the well established trades, and yet years of apprenticeship are required in these trades.

This is in no sense an argument against the establishment of such temporary limitations as are best suited to guard against danger from ill advised and incorrect application of the process. But unless the nature of the real problem is clearly recognized the minds of many mechanical department officers will be closed to future developments and

limitations, once established, will be considered as permanent.

A few railroads have attacked with energy and thoroughness the economic and technical problems involved in the establishment of intelligent limits and correct practice in the application of autogenous welding. These roads have met with success in fields where the average experience has been failure and their success is justification for the belief that future developments will undoubtedly make possible a considerable extension of the present limitations. The art is in its infancy and its possibilities for the conservation of both labor and material are so great that it would be extremely unfortunate for the railroads if a misapprehension as to the nature of its present limitations were to delay the day when they may legitimately be extended.

Air Operated Chucks

For many kinds of work performed on lathes, especially turret lathes, boring mills and other chucking machines, there is a possibility of greatly increased production by the use of air operated chucks. This is particularly true when an order is put through in which machine operations require the chucking of a large number of duplicate parts. The time required for chucking is reduced many times over by the use of air operated chucks and at the same time the work is held so much more rigidly that it is possible to take heavier cuts and reduce materially the time required for the operations. In mechanical construction, several modern designs of air operated chucks have passed through a sufficiently long and rigorous test period to show up any weak points and objectionable features. Difficulty with the jaw operating mechanism has been largely overcome by the use of special heat treated steel levers and hardened alloy steel pivots. With hardened and ground ways in the chuck jaw slides and draw tubes, both wear and friction have been reduced to a minimum and the proper proportion of operating arms has given ample holding power. The air cylinders have presented another structural weakness, air leakage where the air enters the cylinders, especially on fast running machines, making frequent repacking and adjustment necessary. By finally providing a durable packing to overcome this difficulty and in addition making the chucks economical in air consumption, dust proof and adaptable to any ordinary type of turning machine, air operated chucks are due to come into much more common use in railway machine shops, with a corresponding increase in machine shop output.

The Critical Equipment Situation

In the January issue of the *Railway Mechanical Engineer* there was published an analysis of the railroad situation which showed a very serious shortage of facilities. During the past six months no progress has been made in reducing this shortage and the normal capacity of the railroads is at present not great enough to meet the demands of the traffic. Strikes have interfered with operation and freight has accumulated. So it happens that although the railroads are now handling more traffic than ever before, the situation is very critical. There is danger of fuel shortage in certain sections of the country; industries are not operating at full capacity and shutdowns and serious industrial depressions are threatened unless raw materials and finished products can be handled more rapidly.

A great responsibility rests on the mechanical department in this crisis. Anything short of the highest possible efficiency in transportation during the next six or eight months will be a calamity and it is the duty of every man concerned to see that the roads move as much freight as possible. There are various ways in which this can be accomplished. The first is by seeing that every employee realizes the seriousness of the situation and does his utmost by staying on the job and by doing efficient work. The eight-hour day has reduced the capacity of the shops; they cannot be enlarged to meet the present situation; therefore it is essential that there shall be no slackers.

The equipment situation is so serious that it has become a national question. Locomotives and cars must be utilized to full capacity to handle the nation's business. The percentage of locomotives needing classified repairs is not unusually high, but many engines are held out of service bcause minor repairs are not made promptly. For this reason roundhouse work should receive special attention. The bad order car figures show room for improvement; 180,000 cars, or 7.4 per cent of the freight equipment is in bad order and many cars shown as serviceable are fit only for rough freight or light loading. It may be a difficult task to improve conditions under the present circumstances, but the mechanical department should tackle the job with might and main, realizing that it can perform a great service for the country. If additions to the facilities will speed up the work, every effort should be made to install them. If changes in design will reduce maintenance troubles they should be made. Finally, if the railroad shops cannot handle the work, assistance should be secured from contract shops. The situation demands energetic action and nothing should be left undone that will speed up repairs to the equipment.

NEW BOOKS

Car Design. By L. W. Wallace, M.E. 35 pages, 6 in. by 9 in., illustrated, bound in stiff paper. Copies obtainable from H. Rubenkoenig, assistant professor of railway mechanical engineering, Purdue University, Lafayette, Ind.

This is the second edition of these notes and has been brought up to date to include recently adopted M. C. B. standards and recommended practices. The work does not exhaustively treat the subject, but deals only with such portions of the car as are usually given theoretical consideration by the car designer. It is only intended to meet the needs of classroom work, and is especially valuable to those technical schools giving railway mechanical engineering courses which include car design. The practical car designer may also derive some benefit from the work.

Woods Westinghouse E-T Air Brake Instruction Pocket Book. 258 pages, 5 in. by 6½ in., 55 illustrations, bound in cloth. Published by the Norman W. Henley Publishing Company, 2 West Forty-fifth street, New York.

Any book on air brake equipment must be strictly up to date to be of value, particularly if the book relates to the E-T type, which has undergone very rapid development to meet the ever-increasing demands upon locomotive brake equipment. This book, which has just come off the press, not only contains a full description of the E-T 6, which is the most recent type placed on locomotives, but is a very complete text on the design and operation of the entire E-T equipment and accessory apparatus. The text is admirably illustrated with cuts of the various parts of this apparatus and diagrammatic views showing each zone of air pressure in a distinctive color. This book should be of great assistance to locomotive engineers and others interested in the operation of the E-T brake equipment who are so located that they cannot take advantage of the lectures and demonstration afforded in an air brake instruction car and it should also be of value to traveling engineers, air brake inspectors and instructors not only for the information contained in the volume, but for the reason that these colored diagrams afford a very simple and effective method for instructing others in the workings of this intricate apparatus.

COMMUNICATIONS

MORE LIGHT ON THE SERVICE OF SUPPLY

West Springfield, Mass.

To the Editor:

In the June issue of the *Railway Mechanical Engineer,* under "Communications," is an article signed by General Purchasing Agent on Service of Supply. I am sure every railroad engine house or repair shop man will be interested in this General Purchasing Agent's views, for they express in a few words a full explanation of why the supply parts come to shop late and in about half requirement lots.

A man in the shop cannot devote all his time to repairing engines because the stores department fails to provide the materials required in his shop work. The shop forces must stop progressive operations and spend valuable time looking and planning to get past and deliver a locomotive when an important or perhaps only a trivial item of material is missing. It costs 72 cents per hour to have mechanics searching for parts and $2.00 per hour to hold a locomotive out of service.

My work as an engineer in charge of shop production and scheduling of the work in a locomotive repair shop has placed me in a position where definite values are known, and exactly what the factors are which tend to hold up our shop output. I know beyond a doubt that there is no one factor of distress in all our shop list that is costing more in actual cold cash through lowering of shop output and as a cause for continuing defective parts in service than the lack of an adequate supply of materials. This is our worst shop problem today.

If our General Purchasing Agent could spend one day each month alone among the shop and engine house foremen, learn to know the gang leaders and their troubles, he would not make any such slip as he did by saying "No such thing as work held for material." *Work is delayed every day because of lack of material.*

Men of vision and business determination create their credits as they advance, and see to it that subsequent events produce the requisite profit to meet their obligations. Credit is established and maintained by meeting every business obligation promptly and squarely. Where would any of our large roads have been today had they hesitated to advance because of credits? Harriman, Hill, and others advanced and their credits expanded to meet their requirements.

Suppose, for example, we require three 1¼-inch pipe unions to complete a locomotive out of shop and into service. The store room only received one because the 50 per cent credit after being distributed only purchased one. This locomotive must go into service, and there are, we assume, only two pipe unions, a matter of $1.00 between it and earning $75.00 per day. Our piper spends perhaps an hour searching scrap for old ones; perhaps finds a poor one that may just about half-way hold, or long enough to get out of shop and give the engine house trouble later. This hour's time of piper and helper places this union at a cost of 72 cents + 49 cents, or $1.21. But we are still short one, and the only thing to do is to rob from any locomotive in the shop or from some shop heating pipe. A chance of losing $75.00 per day in service earnings forces anything so long as we obtain the required fitting. Later we will have to replace it by robbing another and the labor charge will average $2.00 each for these fittings.

The vital point is we pay for all our material, even though we have to hide half the cost in labor charge. Give us new material at a less cost to the company and place the cost where it belongs, on the purchasing agent's books, and not on shop pay-roll. The increased saving in the direct purchase will sustain the credit advanced, not to mention the intangible effect in dollars resulting from encouraging the shop men.

Who ever heard of a general purchasing agent crying himself to sleep because a wrecking crane cost $25,000, and perhaps stands 12 months and never is used and passing into an obsolete class every day? Or we must scrap it and purchase a larger one to stand around on the siding, tying up a larger sum and losing more interest. The fact is, when we require this crane we want it at once, and very urgently, and in a few minutes' time it liquidates all this interest and depreciation charge. It is not too much in large wrecks to say a crane may save its entire cost on one job. The same thing applies to material stocks; we should not stock carelessly but wisely, and do it as a feature of good business management. Do not state "The road in possession of the largest stock of live stores is the poorest managed."

You do not cut down on coal because of depleted credits. You spend $2,500 on a locomotive to apply superheat and save coal. Here you advance credit and sustain it on the saving in coal. Nothing strange about it, just good hard-headed, plain business sense.

Frank Roberts.

PIECEWORK NEEDED TO INCREASE PRODUCTION

Roselle Park, N. J.

To the Editor:

I read with much interest the letter printed in the May issue of the *Railway Mechanical Engineer* entitled The Mechanic's Viewpoint. However, I wish to disagree with the author on one point in particular, namely his opposition to piecework and his reasons therefor.

I claim that the time has arrived to again install the piecework system in railroad shops in order to increase efficiency and production, which have fallen during the last two years. It is a well-known fact that a good deal of this reduction in output was due to the abolition of the piecework system. To pay men according to their occupation on a flat base is unjust to the good worker and the poor worker. The one is underpaid and the other overpaid. The workman working at an efficiency of 90 per cent should receive more pay than the one working at 80, 70 or less per cent. This should be done by a proper piecework or bonus system. There must always be an incentive for mechanics to increase production and where this incentive is lacking the best workmen will fall to the level of the average and the supervising forces will have to devote a good deal of their time to keeping the slackers on the job. Your correspondent thinks "indifferent quality" is unavoidable under the piecework system. I don't think so; in fact the contrary is nearer to the truth. With a live piecework inspector on the job and the supervising forces not sleeping it is easier to obtain good workmanship under the piecework system than when working at the day rate. Under the piecework system employees can be held to strict accountability for performing inferior or indifferent work. In some cases where carelessness or neglect is shown they can be disciplined by making them do their work over again without extra pay. This usually acts as a sure cure against carelessness.

As far as the nerves of the nation are concerned, I don't think this should worry us if we approach the subject with a fair mind and spirit. Piecework or bonus prices should be set according to the output of an average good mechanic.

The high cost of living today is due to a large extent to under-production of the American workman. Less is being produced per day per man than formerly and more is being demanded. The logical thing to do then is to produce more, and since a proper piecework or bonus system will work along such lines it should be installed again in railroad shops for the benefit of the faithful railroad mechanics and helpers, the owners of the railroads and the public.

Frank J. Borer.

LOCOMOTIVE FEED WATER HEATING*

Development and Possibilities Outlined with Particular Reference Made to the Open Type of Heater

BY THOMAS C. McBRIDE

THE use of feedwater heaters on locomotives dates back to the beginning of the locomotive itself. There are records of the application of an "open" or "injection" type heater to a locomotive in England in 1827, and an English patent of 1828 describes a tubular heater for the same purpose. Ross Winans of Baltimore applied tubular heaters to two types of Baltimore & Ohio railroad locomotives in 1836. It is worthy of note that the desirability of the feedwater heater for the locomotive was recognized at these early dates, although it must be appreciated that the advantages possible at that time were proportionately greater than at the present time because of the low-steam pressure then in use.

Every conceivable type of heater and all possible sources of heat, even the hot ashes, seem to have been proposed or tried,

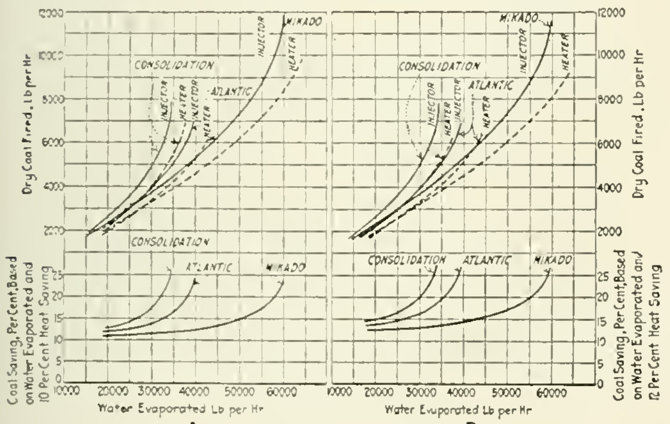


Fig. 1—Curves Showing Estimated Coal Saving with Feed Water Heater

and in view of the amount of study that has been given to the subject it seems rather remarkable that locomotive feedwater heating is not now in more general use. Possibly the reason lies in the fact that it is only in comparatively recent years that the essentials of heater performance and pump operation have been understood. Furthermore the small size of the locomotives formerly in general use limited the saving per locomotive, and the general adoption of the injector, because of its simplicity and convenience, rendered feedwater heating impossible, for injectors heat the water which they use to such an extent by live steam that there is little or no opportunity for further heating.

There are two possible sources in a locomotive from which otherwise waste heat may be obtained to heat the feedwater: (*a*) the waste gases in the smokebox or stack, (*b*) the exhaust steam. Stationary practice with economizers indicates that waste-gas heaters cannot be supplied with cold water because the accumulation of condensation and soot on them seriously interferes with their efficiency. It is, therefore, necessary to turn to the exhaust steam for the source of heat and to develop this type of heater first, leaving the waste-gas heater for later development as may be found either necessary or advisable.

The exhaust-steam heater may be either of the open or injection type in which the exhaust steam comes into direct contact with the cold feedwater so that the water condensed from this exhaust steam is added to and mixed with this feedwater; or, of the closed or surface type in which the heat from the condensation of the exhaust steam passes to the feedwater through thin sheets of metal, generally in the form of thin brass tubes. Practically all of the development work to date that has been at all successful has considered only the surface type. There are a great many heaters of this type in service in Europe, but there are objections to it for locomotive use. It is a complex and delicate structure; it also wastes the water condensed from the exhaust steam with its heat or raises complications as to saving it, and it requires enough exhaust steam to heat all of the feedwater. On the other hand, the open or injection type of heater necessarily recovers both the water condensed from the exhaust steam and its heat so that both are returned direct to the boiler with the water taken from the tender. Less water is therefore taken from the tender and less exhaust steam is required for the heating.

The McBride Feedwater Heater

The adoption of an open heater for the locomotive may seem a radical step, but the author has devised an open type of feedwater heater which is being manufactured by The Worthington Pump and Machinery Corporation and is fully described in the *Railway Age* of Sept. 5, 1919, in which no new elements are used. The heater itself is of a general type that has been in use in marine service for at least twenty years.

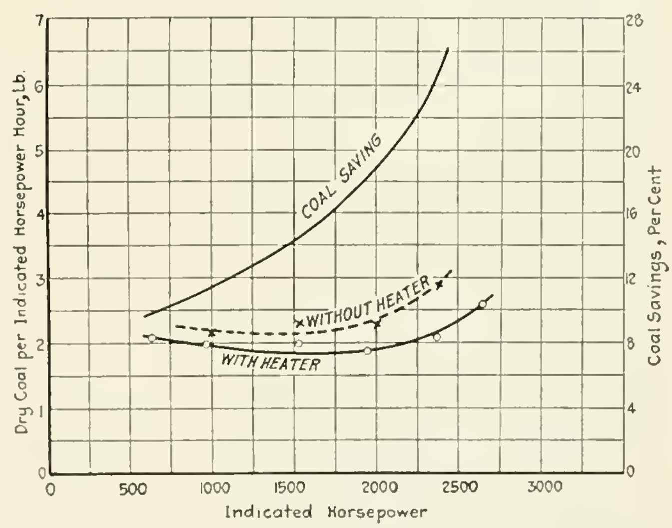


Fig. 2—Curves Showing Coal Saving Based on Test Plant Results

The open heater with the oil separator to remove the oil from the exhaust steam before it enters the heater because of its merits has been almost universally adopted for stationary plants. One of these heater and pump units was thoroughly tested out on the locomotive test plant of the Pennsylvania Railroad at Altoona, Pa., in 1917, and has been in operation on road service since October, 1918. Three more units have been in operation for approximately a year on pooled locomotives and have given no trouble other than the usual pump maintenance. Nothing has developed indicating that the open heater as a type is not well adapted to the locomotive and the coal and water savings have been so marked as to be evident to the crew.

The pump is much easier to operate than an injector, as it

*From a paper presented at the spring meeting, St. Louis, Mo., May, 1920, of the American Society of Mechanical Engineers.

requires only a slight turn of the 1-in. throttle valve to either start it or to make it run faster or slower as the boiler may need more or less water. It does not require priming and can be operated continuously at low capacities where the injector must be stopped and started periodically. The feed pump should not be used, as is often done with the injector, to fill the boiler on the down grade and then be shut off as long as possible on the up grade; first, because there is not as much inducement or necessity for operating it in this way and, secondly, because the prime purpose of the heater is to recover heat and it can only do so when the locomotive is pulling and exhaust steam is available for the heating. If the injector is operated continuously and maintains a constant water level in the boiler each pound of steam generated will require 1,276 B.t.u. from the fire with 200 lb. steam pressure, 150 deg. superheat, and 40 deg. water in the tender. If the injector is shut off each pound of steam will require somewhat more than 925 B.t.u. so that the amount of steam from the same fire will be increased less than 38 per cent. It will later be shown that under the same conditions the feedwater heater would increase the amount of steam about 13.6 per cent. The feedwater heater will, therefore, materially increase the amount of steam on the up grade, although not to the extent possible in the case of the injector, and should be depended upon to feed the boiler entirely on the up grade with the consequent greater amount of heat recovered from the exhaust and more nearly constant water level in the boiler.

Advantages of Locomotive Feedwater Heating

It is not possible to make an exact general statement of the advantages to be obtained from locomotive feedwater heating, because much depends on the particular locomotive to which the heater is to be attached, the capacity at which it is worked, the temperature of the water in the tender, and the basis on which the advantages obtained are stated. We are liable to base our notions as to the advantages of feedwater heating on the results obtained in stationary practice where the coal saving is very properly considered as equivalent to the reduction in the amount of heat necessary to evaporate the water because of the higher temperature at which the water is delivered to the boiler. In the case of the locomotive, however, with its very complicated relations of the different operations that are going on, and the very wide range of capacity through which the boiler is operated, there is generally a much greater coal saving than in stationary practice. Three factors enter into the final result: 1, the reduction in the amount of heat required to evaporate the water in the boiler, which might be called the *heat saving due to the feedwater heater*. 2. The reduction in the amount of heat required results in a greater reduction in the amount of coal required because of the better efficiency of the boiler at the lower rate of combustion. These two factors give the *coal saving based on water evaporated*. 3. The exhaust steam taken by the heater from the exhaust ports of the locomotive reduces slightly the back pressure in the locomotive and should show some advantage. All three factors combined will give the *coal saving based on indicated horsepower*.

Heat Saving Due to Feedwater Heater

The first factor, the heat saving, is determined by the amount the feedwater is heated by exhaust steam taken from the locomotive. This factor will evidently be greatest when the tender-water temperature is low and when the exhaust steam pressure in the heater is highest, as this pressure determines the temperature to which the feedwater can be heated. This pressure will be highest when the locomotive is working hard, and when the exhaust steam for the heater is taken from that part of the steam valve chests or cylinder saddles where its pressure is greatest. The exhaust steam from the feed pump need not be wasted, since it can be and is used in the feedwater heater, but this use prevents the recovery of the same amount of exhaust steam and heat from the exhaust of the locomotive. The amount of steam used by the feed pump is, therefore, a direct charge against the saving due to feedwater heating as compared to injector operation when considered in the light of recovery of waste heat from the locomotive exhaust, or when estimated by the temperature rise of the feedwater in the heater.

The tabulation given in Table 1 is based on heating the feedwater to 215 deg. This is quite conservative, as it has been found easily possible to obtain this temperature with the open type heater referred to even with tender-water temperatures of 40 deg. and on locomotives worked at less than two-thirds of their maximum steaming capacity. The tabulation shows that greater heat saving is possible with saturated than with superheated steam locomotives; therefore the percentage of coal saving will be greater with saturated than with superheated steam locomotives. Table 2 gives the exhaust steam required for the heating. The percentage of water saved is shown by Table 3.

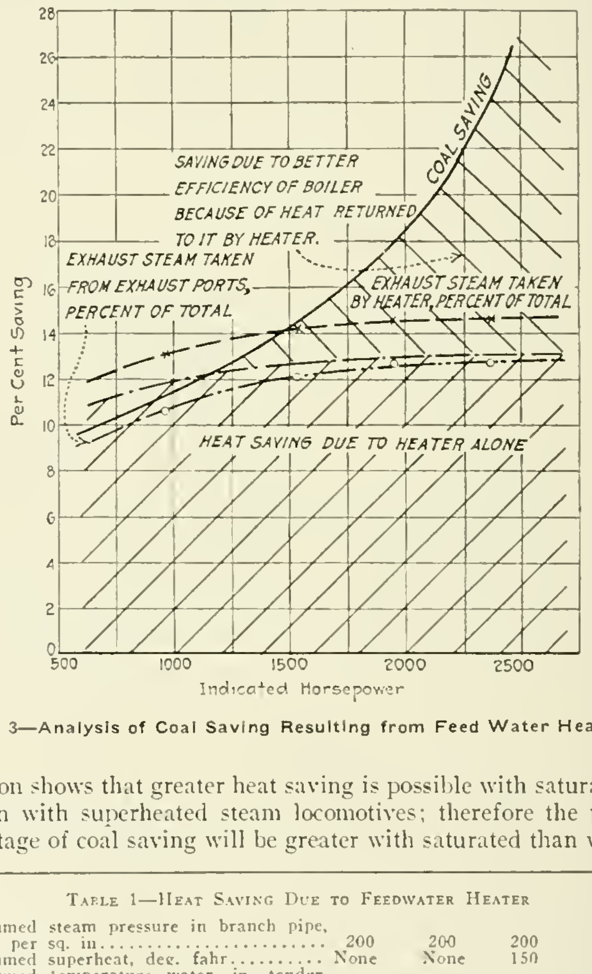


Fig. 3—Analysis of Coal Saving Resulting from Feed Water Heating

Table 1—Heat Saving Due to Feedwater Heater

Assumed steam pressure in branch pipe, lb per sq. in.	200	200	200	200
Assumed superheat, deg. fahr.	None	None	150	150
Assumed temperature water in tender, deg. Fahr.	40	70	40	70
Heat content per pound of steam, B t.u.	1199.1	1199.1	1284.6	1284.6
Heat content per pound of water, B t.u.:				
At 40 deg.	8.0	.....	8.0	.....
At 70 deg.	.....	38.0	.....	38.0
Heat required to generate one pound of steam, B.t.u.	1191.1	1161.1	1276.6	1246.6
Heat saving in B.t.u. when water is heated from:				
40 to 215 deg.	175.0	.....	175.0	.....
70 to 215 deg.	.....	145.0	.....	145.0
Heat saving, per cent	14.7	12.5	13.7	11.6
Total heat required by locomotive with feed pump as compared to injector operation, per cent	102	102	101.75	101.75
Heat saving in locomotive with heater as compared to injector operation, per cent	15.0	12.75	13.94	11.80
Heat required, per cent	87.0	89.25	87.81	89.95
Heat saving as compared to injector operation, per cent	13.0	10.75	12.2	10.05

The allowances which have been made for the steam used by the feed pump are based on carefully conducted tests of the feed pump and heater, which show that this feed pump when running with saturated and fairly wet steam required for its

operation 2 per cent or less of the weight of steam generated by the boiler. The feed pump, therefore, uses 2 per cent or less of the heat required from the fire by the saturated steam locomotive, but in the case of superheated steam locomotive the feed pump will require but about 1.75 per cent of the heat from the fire of the locomotive because of the greater heat required to generate the superheated steam. The tabulation is based on steam leaving the branch pipe at 200 lb. pressure with 150 deg. superheat in the superheated steam locomotive and gives value of the heat saving, water saving, and percentage of exhaust steam required by the heater for tender-water temperatures of 40 and 70 deg. respectively. The term "heat content" is used to express the amount of heat in the water or steam above that in water at 32 deg. Fahr. temperature.

Table 2—Exhaust Steam Required for Heating

Assume tender water temperature, deg. Fahr.	40	70
B.t.u. required to heat one pound of feedwater to 215 deg.:		
From 40 deg	175	.....
From 70 deg	...	145
Heat content of exhaust steam assumed at 7 lb. pressure B.t.u. per lb.	1157	1157
Heat content of water at 215 deg. B.t.u. per lb.	183	183
Heat given up by exhaust steam in condensing from 7 lb. pressure to water at 215 deg. B.t.u. per lb.	974	974
Exhaust steam required to heat one pound of cold feedwater, per cent	18	15
Exhaust steam to heater from feed pump, per cent	2	2
Exhaust steam from exhaust ports of locomotive required by surface heater, per cent	16	13
By open heater, per cent	13.8	11.5

From the tabulation it will also be noted that in the case of the feedwater heater for the locomotive, because of its comparison to injector operation, it is not possible to apply the usual short rule customary in stationary practice stating that a certain number of degrees of heating of the feedwater results in 1 per cent heat saving, but rather that it is more exact to state, assuming the conditions of the table, that in the saturated steam locomotive, after the first 23.8 or 23.2 deg. heating, each 11.9 or 11.6 deg. of heating represents 1 per cent heat saving, and that in the superheated steam locomotive after the first 22.3 or 21.8 deg. of heating each 12.8 or 12.5 deg. of heating represents 1 per cent heat saving, the first figures in each case applying with 40 deg. and the second figures with 70 deg. water temperature.

Table 3—Water Saving Due to Feedwater Heater

Steam for locomotive cylinders, per cent	100	100
Steam required for feed pump, per cent	2	2
Water required by locomotive with surface heater discharging water condensed from exhaust steam to track, as compared to injector operation, per cent	102	102
Exhaust steam condensed in heating feed water, per cent:		
0.18 × 102	18.4	.....
0.15 × 102	.....	15.3
Water required by locomotive with open heater or surface heater saving condensation from exhaust steam compared to injector operation, per cent	83.6	86.7
Water saving, per cent	16.4	13.3

The locomotive with the open heater or the surface heater saving the water condensed from the exhaust steam requires the extra 2 per cent steam to operate the feed pump, but from 15 to 18 per cent of this 102 per cent is recovered, so that the net water saving is from 13.3 to 16.4 per cent respectively for the assumed summer and winter conditions as compared to injector operation.

Coal Saving Based on Water Evaporated

In order to obtain the coal saving based on water evaporated it is necessary to consider particular locomotives, since this factor involves the change in the efficiency of the boiler with varying boiler capacity. For this purpose the curves of Fig. 1 have been prepared. The curves on the left marked A are on the basis of 10 per cent heat saving; those on the right marked B on the basis of 12 per cent heat saving. The upper solid curves marked "injector" are test plant results of a consolidation, atlantic, and mikado type locomotive respectively and show the total amount of water evaporated per hour against dry coal fired. The dotted curves marked "heater" for each of these three locomotives show the amount of water that would have been evaporated by the same amount of coal with a feedwater heater reducing by 10 per cent and 12 per cent respectively the amount of heat required to evaporate the water and superheat the steam. The vertical distances between the solid and dotted curves represent the amount of coal saved and these quantities are shown in the lower set of curves. This lower set of curves, therefore, shows the coal saving based on water evaporated due to the feedwater heater that follows a reduction of 10 per cent and 12 per cent respetively in the amount of heat necessary to evaporate the water and superheat the steam. These curves show that the feedwater heater attached to a locomotive will effect a coal saving beginning at low capacities practically identical with the heat saving, or the coal saving which we have been accustomed to in stationary practice, but which increases at first gradually and then more rapidly as the capacity of the locomotive is increased, reaching values twice or more than twice these figures as the maximum capacity of the locomotive is approached. It would be difficult to credit this result were it not warranted theoretically by the second factor mentioned above, and had it not been confirmed in test plant results with a wide margin to spare. A study of the upper curves in connection with the lower curves of both figures will show that the very great coal saving possible is accompanied by an increase in steaming capacity due to the feedwater heater and that it should be possible to work the locomotive with the heater at greater steaming capacities than are possible with the injector, but how much greater would depend largely on the particular locomotive.

Coal Saving Based on Indicated Horsepower

Saturated steam locomotives should show a further gain of a few per cent from reduced back pressure. Test plant records show some reduction in this back pressure in superheated steam locomotives accompanied by a reduction in superheat and indicate that, at least until further tests are made, this factor should not be considered for superheated steam locomotives. The curves shown in Fig. 2 are based on test plant results of a mikado locomotive, comparing its operation with the injector and with the feedwater heater referred to in this paper. Table 4 shows the heat recovered by the feedwater heater and Table 5 the coal saving and increase in efficiency. They show a coal saving curve of the same general

Table 4—Heat Recovered by the Feedwater Heater

Test No.	1	2	3	4
Steam to engine, lb. per min.	314.5	492.8	599.1	757.3
Steam to feed pump, lb. per min.	7.4	10.5	12.5	14.6
Steam to safety valve, lb. per min.	0.8	0.7	2.1	5.5
Exhaust steam condensed, lb. per min.	42.3	71.4	90.0	113.7
Heat in steam, B.t.u. per min. to engines	402,749	639,063	780,867	996,531
To feed pump	8,876	12,594	14,994	17,393
To safety valve	960	840	2,519	6,597
Total heat in steam	412,585	652,497	798,380	1,020,521
Heat recovered from exhaust, B.tu. per min.	50,725	85,694	108,063	136,736
Per cent of total heat	12.3	13.1	13.5	13.4

Table 5—Coal Saving and Increase in Efficiency with Feedwater Heater

Test Nos.	1 and 5	2 and 6	3 and 7	4 and 8
Speed in m. p. h.	14.6	14.6	22.0	22.0
Indicated horsepower:				
Without heater	990	1549	2001	2388
With heater	965	1534	1949	2373
Coal per indicated horse-power hour, lb.:				
Without heater	2.2	2.3	2.3	2.9
With heater	2.0	2.0	1.9	2.2
Coal saving by feed heating, per cent.	9.1	13.1	17.4	24.7
Drawbar horsepower:				
Without heater	824	1289	1690	2019
With heater	785	1293	1679	2055
Thermal efficiency of locomotive, per cent:				
Without heater	7.0	6.7	6.7	5.4
With heater	7.6	8.0	8.6	7.8
Increase in efficiency with heater, per cent	8.5	19.4	28.3	44.4

character, but slightly higher than the curve for the mikado locomotive of Fig. 1, based on water evaporated, although the tests were made under practically identical operating conditions as to temperatures and pressures.

Exhaust Steam Available for the Draft

The question has been raised as to whether the exhaust steam taken from the locomotive by the feedwater heater would cause trouble with the draft. This question could be analyzed from the partly theoretical curves of Fig. 1, but as actual operating conditions are of more interest, curves have been added to Fig. 3 showing the total exhaust steam taken by the heater and the exhaust steam taken from the exhaust ports of the locomotive. The distance between these two curves represents the exhaust steam furnished by the feed pump to the heater. It is noted that the curve of exhaust steam taken from the exhaust port is below the curve of coal saving. The feedwater heater, therefore, reduced the amount of coal burned at a greater rate than it reduced the amount of exhaust steam, so that there was a surplus of exhaust steam left available for the draft, no necessity for reducing the size of the blast nozzle and consequent possibility of reduced back pressure in the locomotive cylinders because of this heater. For instance, at 2000 i.h.p., the reduction in the amount of coal burned was 18 per cent, and in the amount of exhaust steam, 12½ per cent. As compared to injector operation, 82 parts of coal had to be burned and 87½ parts of exhaust steam were left available for the draft to burn it.

Conclusions

Viewed from the standpoint of coal and water saving, the adoption of the heater becomes a question of interest on first cost, depreciation and maintenance cost against these savings. Viewed from the standpoint of increased capacity, the question becomes one as to whether the feedwater heater does not offer increased capacity at the lowest first cost, especially if, as in the case of the comparison of the consolidation locomotive with and the mikado locomotive without a heater, the adoption of the heater permits of the use of a simpler and less costly type of locomotive. The feedwater heater offers a solution of the pressing problem of these times, when so many fairly old and small locomotives have outgrown their usefulness because they are not large enough for present-day demands. The feedwater heater will not only increase the capacity of these locomotives, or what might be called their economical operating capacity, at a comparatively low cost and with little change in them, but it will also show a larger percentage of coal saving because of their full loading than would be obtained with present-day larger locomotives. The feedwater heater offers the peculiar advantage of being of most assistance to the locomotive just at the time when the locomotive needs assistance. It offers its greatest saving in fuel or increase in capacity in the winter time, and these advantages are not effected by reduced steam pressure or superheat, but continue in spite of them and at a proportionately greater rate.

There was a man in our shop, he was so wondrous wise; he wouldn't wear his goggles—now he has no eyes—*Fred Meyers.*

Method of Keeping Compressor Valves Clean.—Air compressor valves in a certain plant, after a few days' run, would cake with dirt and rust and show signs of corrosion. The explanation offered was that carbonic acid formed by the carbon dioxide and moisture of the air attacked the valves and caused the trouble. It was suggested that a weak alkali such as a soap solution would be sufficient to neutralize the acid and prevent the trouble. One quarter pint of soapy water was fed to the low pressure lubricator three times a day, and since that time the valves have remained clean and have a mirror-like polish.—*The Atlantic Lubricator.*

SPECIAL LOCOMOTIVE DEVICES ON THE ANN ARBOR

In March, 1919, two 11-in. air compressors were applied to a locomotive on the Ann Arbor Railroad, the piston rods to these pumps being drilled and equipped with special means for the lubrication of the air cylinders as shown in Fig. 1. The special features involved in this means of lu-

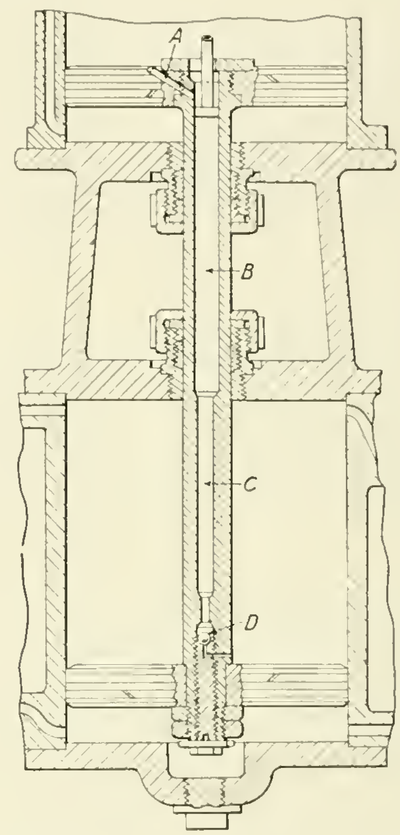


Fig. 1—Arrangement for Lubricating Air Cylinders

brication were designed by J. E. Osmer, superintendent of motive power of the Ann Arbor, and application for patents covering the novel features of the device has been filed.

The air intakes consisted of pipes leading down at an

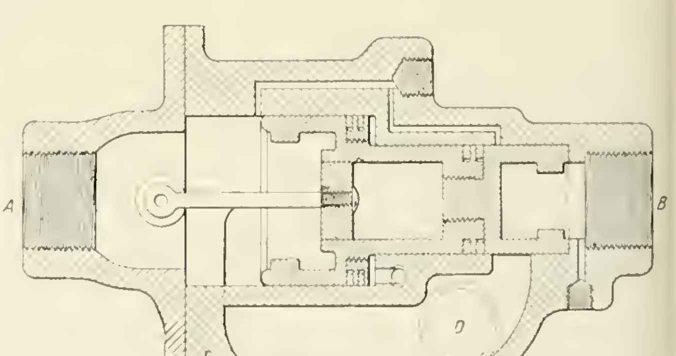


Fig. 2—Combination Valve for Distributing Superheated Steam

angle of about 20 inches from the air cylinder, and on the lower end of the pipe Westinghouse air strainers were applied, thereby preventing any oil getting to the air cylinders from any other source than through these piston rods. On

the downward stroke with steam pressure exerted to the top side of the piston, pressure is also exerted above the oil and water collected in passages holding ball *D* down to its seat. On the upward stroke and if the piston in the air cylinder has traveled one inch, enough pressure has been accumulated to raise ball *D* off the lower seat and force it against the upper seat, thereby permitting the oil and water collected in cavity *C* to pass into and against the cylinder walls.

It is stated that since the application of this arrangement to the air pumps, no indication of groaning has been experienced, and the air passages and the air discharge pipes are absolutely free from carbon. These pumps have run one year between the shoppings of this locomotive, and when the pumps were dismantled it was found that there were no indications of scoring. The same air valves and seats were put back into the pumps and the same pumps are now in service giving satisfactory results.

At the time this installation was made, an automatic valve was also installed as shown in Fig. 2, the duty of which was to furnish superheat steam to the steam end of the air pumps at all times when the throttle of the locomotive might be open, and since the date of its application over a year ago, an increase in speed of the pumps has been noticed with the use of superheated steam over the use of saturated steam when the main throttle is closed and a considerable fuel saving has been observed. This same arrangement also has a special field in connection with the operation of locomotive stokers, coal pushers, and other devices.

Superheat steam from the superheater header on the steam pipe is connected at *A*. The usual steam pipe from the boiler head ordinarily connected to the air pump, steam heat stroker, etc., may be connected at *B*. *C* is the steam delivery pipe to air pumps, steam heat pipes, etc. *D* may be used as a connection to furnish steam to the electric generator. When the differential piston moves to the left, the rounded end of the piston rod seats against a copper gasket, making the joint absolutely steam tight. At the end of the smaller portion of the differential piston, this being cast iron against cast iron, no wire drawing of steam is noticeable due to the fact that in the passage *B* and in the conducting passage to *C*, pressure being practically balanced, eliminates any wire drawing.

Railway Fuel Association Proceedings

Reports and Papers on Feed Water Heaters and Possibilities of Lignite and Carbonized Coals

The twelfth annual meeting of the International Railway Fuel Association was held at the Hotel Sherman, Chicago, May 24 to 26 inclusive, with H. B. McFarland, engineer of tests, Atchison, Topeka & Santa Fe, presiding. The convention was opened with an invocation by Dr. Frank Gunsaulus, president of Armour Institute of Technology, followed by an address by Roy V. Wright, editor of the *Railway Mechanical Engineer.*

Mr. Wright's Address

The International Railway Fuel Association can well be proud of its record. But it has a task before it compared to which its past achievements may be said to be little more than a scratching of the surface. The association has developed and placed on record facts as to how and where savings in fuel may be made. It has done much to supply the inspiration and develop the methods by which such savings were made effective; a great deal remains to be done, however, in these latter respects. The success of a fuel conservation campaign depends directly on the degree to which officers and men are inspired enthusiastically and faithfully to do their part as individuals.

Determining how and where the savings are to be made is largely an engineering problem. Getting the job done, however, demands a keen and thorough understanding of human nature, supplemented by the ability of a salesman or a promoter. It is not enough to attempt to educate men (I use this term to include both officers and men) as to the right way of doing a thing; some incentive must be offered to raise and maintain their interest at a high point. Men are not very different from children. Their attention is caught and retained for a while by one interest and then it restlessly moves on to another.

The men who are selling the idea of fuel conservation to their fellows in the organization must therefore not only study occasionally to change their methods of approach in order to maintain the interest of the men at a high point, but they must be so intimately in touch with the feelings of the men that they will guard against allowing the task to become arduous and will skillfully introduce into it all the spirit of playing a game. We have many experts to tell us how to conserve fuel down to the minutest detail. What we need is more promoters who can stir up enthusiasm and direct the energies of the officers and men along the right channels in carrying out these details.

For years many of us have felt that a large part of the problem of fuel conservation would be solved if we could develop some means of furnishing prompt and accurate records of fuel performance for each locomotive run. This looked most promising until we came to a fuller realization of the fact that almost every one on the railroad from the chairman of the board down to the call boy had some influence on the fuel performance. Why confine the measuring stick to the engine crew when so many other men enter into the problem of using fuel economically and efficiently?

While individual fuel performance records have their value, if they can be promptly and accurately obtained, would it not be better to get the whole team to work together as a unit to beat its own record, or that of its neighbors? The amount of coal used on a division and the train performance statistics can be determined fairly accurately. Two divisions may not be directly comparable, but suppose two divisions on the same or different roads, led in friendly competition by their superintendents, should try to see which one could make the best percentage of improvement. The idea is not new; its value in fuel conservation has been forcefully demonstrated within the past year.

When the fuel conservation promoter has this sort of a campaign going it will not be so necessary laboriously to teach the different men exactly how to do their part of the work. They will develop initiative and interest and will get after the expert or instructor rather than wait for him to get after them.

There is much indifference among the men in railroad service today. In the interests of the public the men, the management and the owners this must be overcome—and overcome quickly. One great difficulty in getting better results is that the men and officers are too far apart and do not really

know each other. If they did know each other better a lot of foolish misunderstandings would be wiped out. You can't carry out a program such as the one above mentioned without getting the men and the managements closer together.

There is another phase of the fuel conservation question which is deserving of special emphasis at this time. The Fuel Association is strong enough to take a real stand in attempting to correct some deep-seated abuses which reach back into the very heart of railway operation and management and bulk much larger than even the entire annual fuel bill of the railroads because they are a source of continuing waste not only in fuel but in other important items of cost of operation.

What will happen if instead of looking too intently upon fuel conservation as an end in itself we consider fuel performance as a barometer of efficient and economical operation? How many roads know what is the economical speed of a freight train over a given division? Why do they not know? It is comparatively easy to determine. How much can the capacity of a division be increased and the economy of operation be improved by modernizing the power? What will it mean if really adequate facilities are provided for keeping the cars and locomotives in first class operating condition? What a wonderful saving could be made in fuel and other operating expenses if some real brains and money were expended in providing business-like locomotive terminal facilities instead of having engine houses which without much imagination can be described as "dark holes with walls around them!" How do you know that a certain type and size of locomotive is best suited to the conditions on your road? You ought to know! Do your train despatchers ever get out over the division, or are they glued to office chairs with distorted visions or imaginations as to what is really going on over the division? You ought to be the fellows to help supply the dynamite to jolt them loose.

All these things and others which you will call to mind—which the association has fully recorded in its proceedings—will affect fuel consumption as much or far more than can be done by the average engine crew. The call today is for the Fuel Association with its great influence to go to the very roots in tackling the fuel conservation problem in a really big way. The conditions are ripe; now is YOUR opportunity! Will you grasp it?

President MacFarland's Address

In his address Mr. MacFarland confined himself to matters pertaining to the welfare of the association, dwelling particularly on the increase in the cost of conducting the work of the association, the largest part of which is involved in the publication of the proceedings. In calling attention to the proposed increase of $1 a year in the annual dues, he reminded the members that the value of the proceedings is much more than the full amount of the dues. In referring to future work for the association, Mr. MacFarland suggested the development of a standard of fuel performance for locomotives. At the present time all fuel performance records are comparative, with no basic or potential standards, and he suggested the investigation of the possibility for the development of a formula for fuel performance in which

H. B. MacFarland (A. T. & S. F.)
President

W. J. Bohan (Nor. Pac.)
Vice-President

J. B. Hurley (Wabash)
Vice-President

W. L. Robinson (B. & O.)
Vice-President

J. G. Crawford (C. B. & Q.)
Secretary-Treasurer

all the variables are included as factors, as an important subject for the consideration of a standing committee of the association.

REPORT OF COMMITTEE ON FEED WATER HEATING

The feed water heaters of today may be divided into the following general classes:

1. Waste gas heaters,
   a. Gas tube,
   b. Water tube.
2. Exhaust steam feed water heaters,
   a. Closed and open types.

The gas tube feed water heaters are used by the various railroads where the Mallet type locomotives have been developed. This type gives a rise in temperature of 70 deg. when new, but in bad water districts this efficiency is lowered rapidly, due to scale forming on the heater surface.

Very little has been accomplished with water tube heaters of the waste gas type, although it has been the subject of much experimental work. Waste gases passing through the front end will average about 600 deg. in temperature, but the rate at which heat can be transmitted from these gases to the feed water is so low that it necessitates a very large heating surface in the smokebox to utilize any appreciable quantity of this heat.

Tests have recently been run on the Santa Fe system with a feed water heater of the Thompson (front end, water tube) type. After this heater had been four months in service, tests were made. The rise in feed water temperature was 30 degrees. An examination of the heating surface showed that in the four months' time 1/16 in. of scale had formed on the feed water heating surface. Tests were also made at this time, using a pump in place of the injector, and approximately 70 deg. rise in temperature was secured. No facilities had been designed whereby the scale could be removed, so it was removed after this test was made.

With proper means for the removal of scale and sediment the waste gas heater can be made an effective instrument for the removal of scale forming ingredients and other impurities before they are carried into the boiler.

The exhaust type feed water heaters, due to the lower temperatures, made it practically necessary to use a steam pump in place of the injector. This type is very attractive, due to the fact that the transfer of heat from steam to a heating surface is about ten times that of the transfer of heat from waste gases. This allows a rather compact system and the feed water can be brought to within 10 or 15 deg. of the temperature of the exhaust steam.

The closed type of exhaust steam feed water heaters in use in this country are as follows:

Weir feed water heaters, two of which are installed for test purposes on the Southern Railway. The troubles to date with this system have been that the water hammering on the pipes between the pump and feed water heater causes leaks and the expansion and contraction in the feed water heater itself causes leaks between the copper tubes and cast iron tube plates. A re-designed heater has been planned so as to take care of this latter trouble.

The second feed water heater system of this type developed in this country is that manufactured by the Locomotive Feed Water Heater Company. This heater has been in service on the New York Central, the Delaware & Hudson, and the Delaware, Lackawanna & Western railways, and to date in the current year the following applications have been or are being made: Central Railroad of New Jersey, Fort Smith & Western, Canadian Pacific, Grand Trunk and Erie railroads. Additional equipments are being supplied to the Delaware & Hudson and the New York Central. The design is made so that the expansion and contraction of the brass tubes is taken care of so that no leakage occurs.

In order to increase the effectiveness of the heating surface in the brass tubes a corrugated spiral agitator of thin brass is placed in each tube. This agitator more than doubles the transfer of heat across each square foot of heating surface, and the high velocity and scouring action of the water caused by its presence tend to prevent lodgment of scale or dirt on the heating surface. Not the slightest particle of scale or dirt has ever been found in the heaters now in service. No experience, however, has been obtained from very bad waters.

The open type heater in service is the McBride feed water heater and pump, manufactured by the Worthington Pump & Machinery Corporation. There are four in service on the Pennsylvania on locomotives in service out of Altoona, Penn. These have been in service for about a year. The feed water heater and pump are combined and are designed for a capacity of 60,000 lb. of feed water per hour.

The exhaust steam passes through an oil separator enroute to the feed water heater. No trouble has been experienced so far from oil passing through the oil separator with the exhaust steam and being delivered to the boilers with the feed water. On road tests the increase in evaporation per pound of coal was 14.4 per cent for the heater.

The development of the locomotive feed water heater is not a question of theory, but of design. A locomotive feed water heater must be capable of continuous operation under the most adverse conditions; it must not add appreciably to the difficulty of controlling water supplied to the boiler at any required rate; it should not increase the weight on driving wheels to the extent that it becomes necessary to reduce the dimensions of the boiler, and it should be applicable to existing locomotives without necessitating radical alterations.

The substitution of a pump for an injector is the most difficult problem connected with the feed water heating. It complicates the control of boiler feed, increases locomotive maintenance and weight, and is in itself not as efficient nor reliable an instrument as the injector. On this account the success of a locomotive feed water heating hinges very largely on the design of a successful pump, unless a practical heater of the waste gas type can be designed which will raise feed water temperatures sufficiently to effect an appreciable saving with the use of an injector.

No great progress in feed water heating can be expected until the solution of the problem is actively taken in hand by the railroads with a determination to make feed water heating a practical operating factor. The committee urges that the mechanical department of each railroad endeavor to lead in this development. We should each endeavor to be a pioneer in the practical application of the feed water heater.

The report was signed by E. E. Chapman (chairman), A., T. & S. Fe.; E. A. Averill, Loco. Feed Water Co.; O. S. Beyer, Jr.; E. V. De Vilbiss, Penn. System; J. S. Hampson, Rosengrant Coal Co.; F. Kerby, B. & O.; Monro B. Lanier, Monroe-Warrior Coal & Coke Co.; L. G. Plant, *Railway Mechanical Engineer*, and L. R. Pyle, Loco. Firebox Co.

Discussion

E. A. Averill (Locomotive Feed Water Heater Company) stated that there are three essential considerations which must be taken into account in judging the practicability of feed water heater devices. These are (1) safety, (2) reliability and (3) cost of maintenance. Following the ability to meet the requirements of these three points the questions of efficiency, weight of apparatus and cost of installation should be considered. Feed water heaters of the exhaust steam type have now been developed so that the requirements of safety and reliability are fully met; and while installations are too

few to permit accurate figures to be obtained as to the cost of maintenance under conditions which would exist were large numbers of locomotives equipped, experience indicates that the requirements of low maintenance cost have been met satisfactorily.

During the discussion the point was brought out that a saving in fuel greater than could be expected from the actual amount of heat reclaimed was observed in some tests of heaters of the waste gas type. This was attributed to the improved combustion resulting from the decreased amount of fuel consumed, which was great enough to permit the firemen to do a better job of firing than had been possible without the heater.

POSSIBILITY OF LIGNITE COALS

BY S. M. DARLING
Fuel Engineer, United States Bureau of Mines

The nation's resources in the way of solid fuel, while large, are not inexhaustible. During the last twenty years the population of the United States increased 42 per cent, and during the same period our coal consumption increased 172 per cent. Our annual coal consumption in 1919 was about 530,000,000 tons. Should the same rate of increase hold for the next two decades, the consumption in 1940 would be over 1,400,000,000 tons. And it is quite probable that we shall be called on to export many millions of tons annually to South America, Africa and the Mediterranean.

The nation's coal resources of all ranks total 3,553,637,100,000 minable tons of 2,000 lb., nearly one-third being lignite. Of this lignite 964,424,000,000 is in North and South Dakota and northeastern Montana, approximately 23,000,000,000 tons in Texas, and 7,404,300,000 tons in Alaska, and relatively smaller quantities in several of the other Western and Southern States. The lignite tonnage given above includes only true lignite (as distinguished from sub-bituminous).

The Carbonizing Process

I came to the conclusion early in my lignite work that the large way to utilize this fuel was to carbonize it; that is, break it up into its four main divisions of gas, oils and tars, ammonia, and solid residue, the latter being practically charcoal. The fact that the lignite does not coke in the sense that bituminous coal cokes, but rather crumbles, on being carbonized, makes possible a continuous and comparatively inexpensive carbonizing process. The costly element of labor is reduced practically to that required for directing mechanical operations.

The Products of Carbonization of Lignite

(1)	Gas, per ton of lignite (440 B.t.u. per cu. ft.)	10,000 cu. ft.
(2)	Oil and tar	15 gal.
(3)	Ammoniacal liquor	65 gal.
(4)	Carbon residue	955 lb.

The Gas—Of the yield of 10,000 cu. ft. per ton of lignite carbonized, 6,000 cu. ft. are required to carry on the process, leaving a surplus, costing nothing, of 4,000 cu. ft. of 400 B.t.u. per cu. ft., or a total of 1,600,000 B.t.u. yielding 160 hp.-hrs. This power is comparable in cost with that derived from natural gas, and is fully as cheap as most hydroelectric power.

Oils and Tars—Just what is the most profitable disposition in this country for the oil and tar products remains to be determined. Their treatment and marketing is an industry by itself. It is not probable that Germany will ever again control the coal tar product industry, and it is not unreasonable to expect that in the future a large part of the demand for tar products will be supplied from our immense stores of lignite.

Ammonia—The ammonia is contained in the gas and gas water; it may be recovered as ammonium sulphate, a valuable fertilizer, as anhydrous ammonia for refrigeration and other commercial purposes, or it may be treated as a source of other nitrogen products, some of which are of vital importance in the manufacture of explosives.

Carbon Residue—Tests of *carbonized lignite*, for use in suction power-gas producers, in carload lots have proved it to be an exceptional and unexcelled fuel for this purpose. Its chemical composition, as shown by analysis, is about the same as that of Pennsylvania anthracite. For the production of power in this way carbonized lignite is fully equal to anthracite coal, charcoal, or bituminous coke, the standard fuels for such purposes. The carbonized lignite can also be burned satisfactorily on the automatic stokers and grates used to consume the smaller sizes of anthracite. *Carbonized lignite briquets* for domestic service have been made in carload lots, and, ton for ton, compare favorably with anthracite coal, and form an ideal domestic fuel in such rigorous climates as those of North Dakota and Alaska.

The territory naturally tributary to the Dakota lignite deposits embraces North Dakota, South Dakota and western Minnesota. Upwards of 2,000,000 tons of bituminous coal are shipped annually into that territory from Illinois, Indiana, West Virginia, Kentucky, and Pennsylvania. The average haul of this coal is 1,000 miles. If the Dakota lignite were put into stable and serviceable condition, by means of carbonizing and briquetting, this fuel demand could be supplied with an average haul of less than 400 miles. The average freight rate is about four mills per ton-mile. The tonnage mentioned does not include the anthracite shipped into this Dakota territory; this anthracite, carried in lake boats and distributed from the head of Lake Superior, amounts to about 1,500,000 tons annually.

To replace these 3,000,000 tons would require the carbonizing annually of 6,000,000 tons of lignite, yielding 3,000,000 tons of solid fuel, 18,000,000,000 cu. ft. of surplus gas (costing nothing), 45,000 tons of sulphate of ammonia, and 60,000,000 gallons of tar distillates. The Texas lignite situation affords an equally great opportunity for economic saving. And there are many smaller deposits of lignite scattered over the Southern and Western States, where relatively smaller savings can be made in similar fashion.

Preserve the Source of Lubricants

Bringing this lignite onto the market as fuel, with its attendant production of oils, would release large quantities of petroleum and natural gas for other uses. Of our original supply of petroleum, 42 barrels per capita have been used and only 70 barrels per capita remain for the future. About half of the petroleum currently produced is used as fuel for steam raising. The possibilities in the use of petroleum and its products in connection with the navy, airplanes, the merchant marine, automobiles, motor trucks and tractors are so great and vital that before long the use of oil for steam raising will be regarded as an inconceivable folly.

Mr. Requa, Consulting Engineer of the Bureau of Mines and Director of the Petroleum Division of the Fuel Administration, puts the situation in forcible language:

"The operation of hydroelectric generators, of railways and trolley cars, of the machinery of the factories, of internal-combustion engines, for our battleships and our merchant ships—in fact, of all machinery—is made possible by the use of one product, and of one product alone—petroleum. For if there is no known satisfactory substitute as a lubricant its exhaustion spells commercial chaos or commercial subjugation by the nation or nations that control the future source of supply from which petroleum will be derived."

The urgent necessity is upon us now to begin to bring these enormous stores of lignite into use and make them do their proper part of the economic work of the nation. The carbonizing of lignite will place the lignite-bearing regions substantially on a par as regards fuel and power with those parts of the country that are favored with bituminous and

anthracite coal. It will give an equally good domestic fuel in the way of carbonized lignite briquets, better gas, producer fuel in the form of carbonized lignite, enormous quantities of gas to be used for fuel or power purposes, a large tonnage of fertilizer in the form of sulphate of ammonia, and a great amount of oils and tars.

Discussion

The discussion centered around the possibilities of using lignite coal in locomotive service and it was pointed out that the development of the use of lignite briquets depends on the building up of a market for the by-products. The experience in the by-product coke industry in the East indicates that this will be a process requiring considerable time. As an immediate means of making these coals available the possibility of using them in pulverized form has received considerable attention. Comparing the possibilities for the use of pulverized lignite with the bituminous coals from the Eastern and Central fields burned on grates, it was pointed out that the average saving in freight alone would amount to about $1.60 per ton, while the cost of preparing the pulverized fuel, on the basis of a plant having a capacity of 1,000 tons a day, would amount to about 40 cents a ton delivered to the locomotive tender. This includes the interest, depreciation, taxes and insurance on an investment of $250,000 required to install such a plant. In experimental work it has been possible to pulverize lignite with as high as 18 to 22 per cent moisture remaining in it. If this practice proves to be feasible commercially, it will eliminate the necessity for a drier of large capacity and the danger of combustion from the high temperature required in the drier to reduce the moisture to the low percentage ordinarily considered necessary in pulverized fuel practice.

The discussion also brought out the fact that some lignites can be burned in their natural form. This is being done very successfully on the Oregon-Washington Railroad & Navigation Company's line. The coal used is a black lignite or sub-bituminous with a heating value of less than 9,000 B.t.u. and 18 per cent moisture. To burn this coal, locomotives are built with large grate area and a large netting area in the front end. An unusually large exhaust tip is used and about one-third of the air is admitted over the fire through a baffle fire door. Because of the comparatively small amount of combustible in this fuel, it requires much less air per pound than the higher grade bituminous coals.

SANTA FE LOCOMOTIVE OIL BURNING PRACTICE AND FUEL PERFORMANCE*

BY WALTER BOHNSTENGEL
Assistant Engineer Tests, A. T. & S. F.

The Santa Fe System has approximately 3,160 locomotives, of which two-thirds use coal and one-third use oil as fuel.

The necessary procedure in converting a coal burner to oil is providing an oil tank of proper shape and size to fit the coal space in the water tank; removing grates, ash pan, and ash pan rigging and applying a fire pan with proper brick lining and burner; and arranging necessary piping on the tender and boiler back head of the locomotive, to regulate the oil outflow to the firebox. All pipe and pipe fittings should be extra heavy, the valves and throttle being of heavy design capable of carrying a maximum pressure of 250 lb.

Firebox and Flues

It has been demonstrated that button head radial stays should be eliminated and taper head radial stays applied. It is the practice to have all rivets countersunk and driven flush. It is also considered good practice to scarf the door and flue sheet flange from the inner edge of the rivet hole to the outer edge of sheet, making the outer edge approximately 3/16 in. thick to prevent undue cracking from the rivet hole to the edge of sheet. It is not considered that firebox troubles are any greater in oil burning locomotives than in coal burners in proportion to the work performed. The troubles experienced in oil burning locomotives consist of cracks developing in the knuckle of the fire door hole, top flange of door sheet and flue sheet, leaky radial stays and staybolts, as well as cracks developing from staybolt to staybolt in the side sheet. Prompt and careful attention is necessary in boiler washing.

Should the side, flue or door sheets have patches applied by rivet or patch bolts, they are liable to give considerable trouble, and should the fireboxes be of the five-piece type, the longitudinal seams in the crown sheet would cause considerable trouble from leaking. It is Santa Fe practice to cover these seams with brick until they require renewal.

The life of a firebox and a set of flues is somewhat less in an oil burning locomotive than in a coal burning locomotive. The average for all locomotives, old and new, large and small, in all classes of service, shows that the life of staybolt fireboxes in coal is 10 years and 3 months and in oil 9 years. This cannot be used to predict the actual probable life of any one box, as the figures vary to a certain extent by reason of different local conditions. The average life of a set of flues in an oil burning freight locomotive is about 48,000 miles, and in a coal burning locomotive, same service about 65,000 miles. The life in passenger service is approximately 40 per cent higher and in about the same relation.

Engine Equipment

The Booth burner is used as standard on the Santa Fe. The patent on this burner expired in February, 1912, and it is made and tested in our own shops. Good results are obtained from 1½-in. burners on small locomotives, while the larger power is provided with 2 and 2½-in. burners. For the Mid-Continent oil, a 1½-in. pipe is used to convey the oil from the tank to the firebox, while with California and Mexican oil 2-in. piping is used to the firing valve.

The larger locomotives having 8,500 and 9,000-gallon water tanks, use an oil tank of about 3,400-gallon capacity. On the smaller locomotives having 5,000 and 6,000-gallon water tanks, the capacity of the oil tank varies from 1,800 to 2,250 gallons.

Comparison of Coal and Oil

The essential features in preparing to burn oil for locomotive fuel is the availability, extent of supply, and relative value of the oil, not at the well, but at the point of consumption.

The coal used on Santa Fe locomotives averages 11,500 B.t.u. and the oil 19,000 B.t.u. per lb. On this basis the theoretical heat value of one pound of oil equals 1.65 lb. of coal. After the ratio of coal to oil is obtained to agree with local conditions, the advantages to be gained by the use of oil may be considered by substituting in the following formula:

$$e = \frac{a \cdot b \cdot c \cdot d \cdot X}{2000} = \text{equivalent price of oil per barrel.}$$

$$d = \frac{2000 \cdot e}{a \cdot b \cdot c \cdot X} = \text{equivalent price of coal per ton.}$$

a = Weight of oil per gallon pounds = specific gravity of oil times weight in pounds of one gallon of water.
b = Number of gallons per barrel.
c = Ratio of heating value of oil to that of coal in B. t. u.
d = Price of coal per ton, dollars.
e = Price of oil per barrel, dollars.
X = Ratio of boiler efficiency, oil to coal.

The results of a number of recent tests on the Santa Fe show that the evaporate efficiency of oil is about 25 per

*A., T. & S. F. locomotive equipment for burning oil was described and illustrated in a paper read before the 1915 convention, an abstract of which will be found in the June, 1915, issue of the *Railway Age Gazette, Mechanical Edition*, page 280.

cent more than coal for hand fired and 40 per cent more than coal for stoker fired locomotives, that is, the factor X is 1.25 for hand fired and 1.40 for stoker fired locomotives.

The cost of changing a locomotive from coal to oil burning depends largely on the size of the locomotive. Recent figures show that the approximate cost of changing a modern locomotive of Pacific, Mikado or Atlantic type is from $2,400 to $2,500, including the construction of an oil tank, draft pan, petticoat pipe, oil burner piping, fittings, etc. This cost would also include the application and the usual overhead charge. A smaller locomotive, such as the eight and ten wheelers, can be converted at a cost of about $1,800 to $2,000 each.

Either the speed of the train or the tonnage is increased on an oil burning locomotive, due to the locomotive being worked to its maximum capacity at all times. A test made in 1919 shows that an oil burning Atlantic type locomotive handled an average tonnage of 750 tons, while the same kind of a coal burning locomotive handled 578 tons in the same class of service.

The Brick Arch in Oil Burning Locomotives

The paper also contains a report of tests on three oil-burning locomotives of the 2-10-2 type, all of the same class, to determine the effect of an arch tube supported brick arch on fuel performance, with the standard location of the oil burner at the front end of the firebox as well as at the rear of the firebox. These two arrangements were compared with the standard firebox arrangement, which does not include a brick arch.

The data for the individual runs during these tests, as well as the average, show a slightly better fuel performance for the locomotives without the arch than for those with a brick arch. However, the atmospheric temperature averaged slightly higher during the runs made without the arch than for those with the arch, which would be favorable to the former in a lower radiation loss.

The data show no saving in fuel, if anything a lower efficiency for the arch, in comparison for the present front end burner arrangement without arch. This can be explained by noting that with proper drafting, without arch as well as with arch, the locomotive can be fired without showing smoke, and having as low a front end temperature without as with the arch. Obtaining complete combustion in the firebox in either case, further economy could only be obtained by absorbing more of the heat from the gases and getting a lower front end temperature. Another explanation for lower efficiency of the arch with oil, is that radiant heat is not utilized to the best advantage with an arch, as the arch shades part of the firebox.

As a general conclusion, taking the present standard arrangement with front end burner and no arch or arch tubes as a basis, the data secured on these tests show that the advantages resulting from the use of an arch tube supported arch with either the front or back end burner arrangement are more than offset by disadvantages and, from these tests, the installation and maintenance of the arch cannot be justified in oil-burning locomotives.

GENERAL SUMMARY OF OIL BURNING TESTS, WITH AND WITHOUT BRICK ARCH

	East Bound				West Bound			
Firebox arrangement	A	B	C	D	A	B	C	D
Number of runs	5	11	4	3	5	10	4	3
Running time, hours	8.35	8.42	8.57	8.15	6.42	6.35	6.25	6.17
Dead time, hours	2.47	3.15	2.62	2.79	2.58	2.95	2.97	2.72
Total time, hours	10.82	11.57	11.18	10.94	9.00	9.30	9.22	8.88
Total oil fired, pounds	25,770	26,970	26,630	26,420	9,550	12,430	11,390	11,160
Total water evaporated, pounds	287,150	293,440	292,140	284,720	108,430	134,940	124,930	119,520
Ratio, water to oil	11.14	10.86	10.98	10.77	11.35	10.86	10.97	10.72
Draft, in. of water:								
Fire pan	....	5.0	7.0	7.5	....	3.8	5.3	5.5
Smoke box	11.2	10.3	11.8	12.5	6.3	7.3	8.5	8.7
Temperature, deg. F.:								
Feed water	75	69	68	63	64	58	58	53
Smoke box	634	643	601	595	525	549	541	548
Fuel oil	117	119	119	113	119	121	127	119
Atmosphere	65	55	53	38	64	52	54	37
Tonnage per train	1,307	1,213	1,353	1,217	1,021	1,364	1,346	1,221
Gross thousand ton miles	191.5	180.9	190.0	181.2	147.2	211.7	200.8	181.8
Speed, miles per hour	17.9	17.8	17.4	18.4	23.4	23.6	24.0	24.3
Oil, pounds per gross thousand ton miles	134.6	149.2	140.1	145.7	65.8	61.6	57.1	61.6
Water, pounds per gross thousand ton miles	1,520	1,660	1,582	1,592	782	699	652	710
Equivalent evaporation:								
Pounds water per pound oil	14.60	14.40	14.47	14.26	14.55	14.14	14.25	14.06
Thermal efficiency, per cent:								
Boiler and superheater	76.4	75.3	75.6	74.5	76.0	74.0	74.5	73.5

All runs were made between Needles, Calif; and Seligman, Ariz., 149 miles.
Firebox arrangements:
A = Without arch tubes or arch; burner at the front end of the fire pan.
B = With arch tubes and arch; burner at the back end of the fire pan.
C = With arch tubes but no arch; burner at the front end of the fire pan.
D = With arch tubes and arch; burner at the front end of the fire pan.

Discussion

The discussion centered around the difficulty resulting from the accumulation of carbon on the bottom of the draft pan in front of the oil burner on oil-burning locomotives. This is being experienced in some cases where oil has only recently been adopted as locomotive fuel, especially where the heavy gravity Mexican oils are in use. On roads which have had considerable experience, the difficulty has been overcome, largely by care in the location of the burner, to keep the flame properly centered in the firebox and away from the bottom of the pan, and by admitting air around the burner, principally under and at the sides of the burner.

In discussing the Santa Fe arch tests, J. T. Anthony stated that experience on other oil-burning roads indicates a saving of from five to eight per cent where the arch is used. He took exception to the statement that the arch tended to shield part of the firebox from direct flame radiation, as the temperature of the arch makes it a radiating medium itself. He admitted that where a boiler efficiency as high as 76 per cent was obtained without the arch there was not much range for improvement left for the arch, but doubted the ability, day in and day out, to maintain such a high efficiency.

REPORT ON FRONT ENDS, GRATES AND ASH PANS

The committee presented data for comparison of two types of grates from tests of two classes of coal, namely, Gallup and Kansas on the Santa Fe. The object was to determine what, if any, saving could be effected by using table grates in place of finger grates in locomotives burning Gallup coal. This coal, obtained from Gallup, New Mexico, is a semi-bituminous coal, having the following analysis:

Moisture, per cent	8.25
Volatile matter, per cent	29.91
Fixed carbon, per cent	51.46
Ash, per cent	10.38
Sulphur, per cent	0.64
Calorific value of coal as received B. t. u., per pound	11,484
Calorific value of dry coal, B. t. u. per pound	12,516

The test was made between Belen and Gallup, New Mexico, in May, 1919. The locomotive used for this test is a single expansion Mikado type equipped with a Duplex stoker and superheater. It was new, having just been received from the Baldwin Locomotive Works. The front end draft arrangement and the brick arch arrangement remained the same, and in the comparison of data of finger and table grates the same fireman was used throughout the test.

The standard finger grates for Gallup coal were installed first, and the brick arch maintained eight bricks high in the center and intermediate rows and seven on the side rows, and all set down against the tube sheet. With Gallup coal, it has been found most economical to run the arch down against the flue sheet and at least seven courses high, on account of stack losses. The standard Gallup coal grates have 5-in. openings between the fingers, while the clearance between the bars on the table grates is ¾-in. with ⅝-in. slots for air passage up through the bars. The percentage of air opening is approximately 37.8 per cent with either design.

The locomotive was run with full compensated tonnage rating, namely, 2,300 tons, Dalies to Gonzales, and 2,700 tons, Gallup to Gonzales.

The million-foot pounds of work done at the drawbar indicated a higher average drawbar pull, a greater amount of total work done, as well as a greater amount of work per hour while working steam with the table grates than with the finger grates. This is the reason for the table grates using more coal and giving poorer evaporation than the finger grates, as the harder the locomotive is worked, particularly where there is much fine coal or slack, the greater the stack loss.

The table grates do not drop any fire and very little ash except when being shaken, while the finger grates drop considerable fire in certain portions where the fingers are cut short to clear obstructions in the corners of the firebox. The shape of the pan (the high sides) causes the hot ashes and fire to sweep up along the side of the cab into the enginemen's faces when a high side wind is blowing. The table grates were very popular with the enginemen on this account; also, on account of being easier to shake. There is very little need of a power grate shaker with table grates and Gallup coal.

Aside from the coal being a little finer and the locomotive being worked a little harder on trips with the table grates, which incurs a greater stack loss, it is possible that the larger coal consumption with the table grates is due to insufficient air admission. While the air openings are calculated to be the same, the ashes or contents of the firebox pack down over the slots in the table grates and there is not the same chance to loosen it up by shaking as with the finger grates. The steaming of the locomotive was about the same with the table grates as with the finger grates.

When all things are taken into consideration, the saving in coal of table grates over the standard Gallup coal finger grates, or vice versa, is very small. Under certain conditions one will show a saving, while under other conditions the other grates may show a saving.

A similar test was made on the road between Argentine and Emporia, Kansas, a distance of 108 miles, with Kansas coal. The same type of locomotive, No. 3209, was used on this test as with Gallup coal and with the same equipment.

The data on the table grates were obtained for the most part by an observer on the locomotive after the test with the dynamometer car had been finished. On most of the trips with the observer on the locomotive, a test on a perforated arch in comparison with the standard seven course arch was carried at the same time. However, the results indicate that the perforated arch cut a very small figure in the saving.

Evaporation is the proper basis on which to make a comparison between table and standard grate. From a summary of dynamometer car data there was shown to be an average saving for the round trip of 8.0 per cent. Based on tests without the dynamometer car the saving averages 10 per cent for the round trip. Under all conditions there was some saving in favor of the table grates, and a conservative estimate would be from 1 to 1¼ tons of coal per trip.

The table grates save coal by preventing it from falling through into the pan only partly burned. The loss from this source is very noticeable with the coarse grates now used, particularly when the coal is fine and starting out of a terminal when the fire is light. Part of this loss could be eliminated by using finger grates with fingers closer together, such as those used for Gallup coal.

There is a considerable loss due to finger grate bars having to be replaced on account of fingers being burned off which loss would probably not be so great with the table grates.

SUMMARY OF THE GALLUP COAL TESTS

	Equated gross 1,000 ton miles	Ratio water to coal		Average boiler pressure, lb.	Coal, lb., per 1,000 ton mile, Belen and Gallup	Water, lb., per 1,000 ton mile, Belen and Gallup	Mileage		Drawbar pull lb.—average		Million ft. lb. of work				Pounds per million ft. lb.		Duration of test		Speed, m. per hr.
		Belen and Suwanee	Suwanee and Gallup				Over division	Working steam	Over division	Working steam	Average per mile: Over division	Average per mile: Working steam	Average per hr. working steam	Total	Coal	Water	Dead time hr., min.	Running time hr., min.	
West Bound—Belen to Gallup, 144.1 miles																			
A	323	4.97	5.18	188	162.8	843	145.40	111.36	20,988	27,421	110.82	144.78	2196	16,112	3.26	16.9	3-48	8-57	16.1
B	318	4.51	4.91	187	179.9	881	145.64	113.31	21,384	27,474	112.91	145.06	2475	16,443	3.47	17.0	2-47	8-10	17.7
C	322	4.92	4.96	188	181.8	902	145.47	113.28	22,266	28,608	117.57	151.05	2314	17,102	3.43	17.0	4-11	8-58	16.2
East Bound—Gallup to Belen, 144.5 miles																			
A	389	...	5.31	187	75.8	402	145.61	51.08	9,996	28,499	52.78	150.48	1951	7,685	3.84	20.3	2-18	7-33	19.1
B	389	...	5.03	187	82.2	413	145.48	55.10	10,054	26,586	53.09	140.37	1869	7,723	4.14	20.9	1-35	7-35	19.0
C	396	...	5.01	187	79.9	398	145.69	53.17	10,303	28,231	54.40	149.06	1988	7,926	3.98	19.9	1-34	7-38	19.0

Note—"A" is the average of five trips in each direction, with finger grates and an eight course arch. "B" is the average of two trips in each direction with finger grates and a perforated arch. "C" is the average of three trips in each direction with table grates and an eight course arch.

Front Ends

During the testing of the Mikado type Locomotive 3209 just referred to, a variable exhaust nozzle designed by Mr. Stevens, a boiler maker on the Santa Fe, was applied for test. This device can be regulated from the cab and gives a discharging area equal to a nozzle area anywhere between 5½-in. and 6-in. diameter. The idea of the inventor was to open up this nozzle when the locomotive was steaming

freely and to close it down at gradients of 1/16 in. when for any reason the locomotive did not steam so freely.

When first applied, in February, 1919, no difference could be detected in fuel consumption, and it was found necessary to put a diamond split in the top. However, as weather conditions got better, the nozzle was run practically wide open all the time. In its operation the nozzle was run either wide open or closed. The specific gradations in closing were not utilized by the enginemen. The chief disadvantage of the variable exhaust nozzle is that if not worked frequently it becomes inoperative in a short time by being stuck up due to the exhaust gases.

At the fourth annual convention in 1912, an exhaustive paper was presented to this association showing the great possibilities in fuel saving and the further possibilities of increasing the power of locomotives by the elimination of back pressure. Information now comes to the committee that a simple and effective drafting system has been developed based on the fundamental assumption in the paper on back pressure, previously referred to, that there was sufficient energy in the exhaust steam to draft the locomotive with a maximum of four pounds back pressure on the cylinders.

The essential features of this system are an exhaust volume chamber and a governing variable exhaust nozzle which opens under very low static pressure and which has a variable opening with each exhaust blast. The variable opening and constant automatic agitation of the wings is most essential in maintaining a variable exhaust nozzle.

In the committee's last report attention was called to the Master Mechanics' formulæ for the design of stack and front end, showing that they are not properly applicable to present power. The Lewis drafting system, with its exhaust blast of very large contact area of steam and exhaust gases, and its unusually large stack, are convincing testimonials that we should no longer abide by this rule of thumb design, but that we should make investigations to find the limit of design which will give the greatest efficiency of the exhaust blast.

The report was signed by H. B. MacFarland (chairman), A. T. & S. F.; W. J. Bohan, Nor. Pac.; E. B. DeVilbiss, Penn. System; J. P. Neff, American Arch Co.; Frank Zeleny, C. B. & Q., and C. C. Higgins, St. L.-S. F.

USE OF CARBOCOAL ON LOCOMOTIVES

BY GEORGE E. SCHERICK, JR.
Fuel Engineer, International Coal Products Corporation

In the firing of bituminous coal many schemes have been tried to promote better efficiency and some of these have met with considerable success. But in spite of all attempts toward better economy the locomotive boiler remains today one of the chief offenders in the extravagant use of fuel. There can be no doubt that the continued demand of the public for abatement of the smoke nuisance will force the railroads to the use of a smokeless fuel or to electrification of their roads in their larger terminals. The limited supply of anthracite in the country makes it unlikely that anthracite can be used generally on railroads, and it is evident that there is a good field for a fuel comparable to anthracite but manufactured from bituminous coal, with a saving of the valuable by-products.

Carbocoal is a dense, smokeless fuel formed by carbonizing bituminous coal. Any coking or non-coking bituminous coal or even lignite can be used in the process, although some coals are more desirable than others. Carbocoal compares very favorably with anthracite coal and has about the same analysis, but it burns with a much less draft. It is manufactured from bituminous coal by carbonization in two stages. The raw coal is first crushed and then fed continuously to horizontal retorts, operated at a relatively low temperature. The volatile matter in the coal is reduced to about eight per cent. This low temperature coke or semi-carbocoal is then ground, briquetted with pitch, and the resulting briquets are carbonized at a temperature corresponding to that used in coke ovens, the by-products again being collected as in coke-oven practice.

The resulting briquet is a smokeless fuel resembling anthracite in its properties and differing considerably from ordinary coke, particularly in that it is a soft form of carbon and much more free burning than coke.

Several carbocoal tests have been made by various railroads in the east, and the results as a whole have been very satisfactory, especially as these tests can only be considered of a preliminary nature.

The first test run on a locomotive with carbocoal as fuel was made on May 21, 1917, and was run to ascertain the possibilities and flexibity in handling when fired on a regular locomotive grate with its draft system. The engine (a switch engine) was equipped to burn anthracite, fuel oil or bituminous coal, and as reported by the superintendent of motive power of this railroad, who was keeping a close watch of this locomotive throughout the day, "the performance on the road was better than with either hard or soft coal. The engine steamed more freely and the fire could be kept in more satisfactory condition, as the briquets did not clinker at all but simply burned up to a fine ash which could be shaken through the grates. In this respect it was superior to any of our ordinary fuel."

It was necessary to shake the grates only four times from the time the fire was originally built. At no time during the test could any smoke be detected coming from the stack. The briquets, despite the many times they had been shoveled from the period following their manufacture to the time they rested in the tender, appeared without any mutilation and with a marked absence of slack and fines. No difficulty was experienced in maintaining a full head of steam. On six occasions it was necessary to start the blower on the engine, whereas the engine crews stated that with coal as a fuel on this particular work it was necessary to keep the forced draft in operation the greater part of the day.

In September, 1917, the Carolina, Clinchfield & Ohio ran a series of two tests with carbocoal. These were run over the same road from Kingsport to Soldier, a distance of 22 miles, with 43, 50-ton cars in the train, and as far as was feasible external conditions were kept constant. No instructions were given the fireman as to the proper methods of handling carbocoal. There was no opportunity to try out the fuel in advance. The firemen in this locality were accustomed to firing high volatile bituminous coal, while the carbocoal corresponds in many ways to anthracite coal.

CAROLINA CLINCHFIELD & OHIO TEST OF CLINCHFIELD CARBOCOAL

Type of locomotive	2-6-6-2
Weight, total engine, lb.	378,650
Tractive effort, lb.	77,400
Grate area, sq. ft.	78
Heating surface, sq. ft.	5,752

Data and results	Run 1	Run 2	Average
Grade, compensated, per cent	0.5	0.5	0.5
Length of route, miles	18	22	20
Tons behind tender	3,022	2,981	3,001
Pull on drawbar (calculated)	43,000	42,250	42,275
Average speed, miles per hour	9.0	10.1	9.55
Fuel burned, sq. ft. grate area, per hour	64.0	98.0	81.0
Water evaporated per sq. ft. heating surface, hr.	6.75	9.70	8.22
Water evaporated per pound of coal	7.77	7.30	7.53
Equivalent evaporated per pound of coal	9.36	8.83	9.09
Fuel consumed per ton mile, train load	.184	*.250	.217

*Allowance has been made for fuel due to safety valves being open at least 19½ min.

In addition to these tests a demonstration was made on the Baltimore & Ohio. This demonstration was witnessed by some of the leading citizens of the community in which it was made, and gave entire satisfaction as a smokeless fuel.

Carbocoal can be stored in unlimited quantities without danger of fire from spontaneous combustion. The storage space per ton for carbocoal is but a few per cent greater than

for coal; further, the carbocoal does not weather and slack as many coals do on storage.

Discussion

Several inquiries were made relative to the commercial possibilities to the railroads and the cost of production. The first commercial plant will commence operation in the Clinchfield district in July and no production costs are available. An estimated investment of three million dollars will provide a capacity of 1,000 tons daily with a net return under the present market of one million dollars annually.

ECONOMICS OF THE FUEL OIL SITUATION

By EUGENE McAULIFFE
President, Union Colliery Company

Within twelve months the fuel oil situation, insofar as present and future supply, as well as unit costs, are concerned, has undergone startling changes. One year ago we were alone concerned with the economical consumption of fuel oil; today there is a national, even international, feeling that the period of fuel oil consumption for steam making purposes is substantially behind us.

After practically effecting the consummation of a very extensive oil burning program the Naval Department asking in March last for Pacific Coast bids on 4,500,000 barrels of fuel oil, received but one bid covering a delivery of but 602,000 barrels, at a price of $1.95 per barrel. In April bids were requested for Atlantic Coast deliveries, five tenders returned, covering an entirely insufficient supply, the price for bunker oil ranging from $2.07 to $3.76 per barrel of 42 gallons. A similar fuel problem confronts the American merchant marine, the completed program of the United States Shipping Board, aggregating 10,000,000 dead weight tons, of which 2,000,000 tons will consist of coal burning vessels and 8,000,000 tons of oil-burning vessels. The estimated fuel oil requirements of the Shipping Board for the year 1920 are forty million barrels, and for 1921 sixty million barrels.

When we consider that the necessity for maintaining a navy will not cease until the end of the existing generally used form of government, or until the millennium arrives, both of which are perhaps quite remote, it would seem very plain that the requirements of the United States Navy, equipped to carry and burn oil will take precedence over any other demand, and it is equally reasonable to assume that after the American people have spent not only millions but billions in the upbuilding of an American merchant marine, that its fuel oil requirements will take position only second to that of our battleships. The statement of men who should know, that 1920 and 1921 will mark the peak period of oil production with a steady decadence from this time forward justifies serious consideration of the oil problem. The United States Geological Survey estimates that with the close of the year 1919 we have taken approximately five billion barrels of oil out of the ground and that the estimated oil reserve yet in the ground is six and one-half billion barrels. Whatever does the future promise?

Between 1909 and 1918 the number of automobiles and trucks increased 1700 per cent, and the consumption of gasoline for automobile purposes jumped from 13,000,000 to 85,000,000 barrels, or 650 per cent, while the production of crude oil increased 95 per cent. Today we operate 7,600,000 automobiles and motor trucks, and 350,000 tractors, and the 1920 construction program totals 2,000,000 automobiles and motor trucks. Power boats, aeroplanes and minor power pumping plants employ thousands of internal combustion engines, all calling for oil and gas. It takes a half pint of oil to translate a ton of coal into power by way of the steam engine, to consume the power so generated takes much more. Without petroleum we could no more grease the bearings and spindles of industry than we could light our great buildings and streets with tallow dips. The total available animal fats, together with that which might be possible to extract from sea life in the period of a year, would not even dimly light and poorly lubricate the world for one-tenth of that time, even though food fats were taken to swell the supply. The government has thrown open for drilling 6,500,000 acres of national oil reserve, but these lands located in California and Wyoming will not add materially to our supply. In 1919 twenty-nine thousand wells were driven, to success or failure; of these 6,000 were dry, 2,000 returned gas without oil, the drilling expense estimated at $600,000,000.

The translation of oil into steam will quickly cease, through the pressure of economic forces and the transportation companies must perforce sense the changes that are taking place in the fuel oil world. Millions of dollars were saved in past years by the substitution of cheap crude oil and refinery residuum for coal in locomotive fireboxes. Only twelve years ago it was difficult to force the skimming plants of Texas and Oklahoma to take sufficient gasoline out of the crude to make its use on a locomotive safe. The railroads who then absorbed the residue left after the taking off of the lighter distillates built up a comfortable refinery traffic for their rails, but a complete return to coal fuel is now imminent. To avoid the necessity for summary and violent changes the work of shifting fuels should be undertaken at once and conducted quietly and gradually. Fifty million barrels of fuel oil represents twelve million tons of coal. This is not a large tonnage if it were not for the fact that the major portion of the oil is consumed where the coal production is relatively small.

Other Papers

The report of the committee on Fuel Stations which was here presented will be abstracted and published in a later issue of the *Railway Mechanical Engineer.*

M. A. Daly, Northern Pacific, chairman of the committee on firing practice, conducted before the association certain simple chemical experiments which are used in the Northern Pacific instruction car to instruct and interest engine crews in the principles of combustion. The discussion showed considerable interest in these methods.

The committee on pulverized fuel reported that efforts to secure reliable comparative cost data during the year were unproductive and the discussion indicated a desire on the part of members for information of this character applicable to decisions on local problems rather than further data of a general character about the process. Such information as was brought out in the discussion indicates that about the only extensive experience in locomotive service has been where low grade, cheap coals, such as anthracite silt, are available.

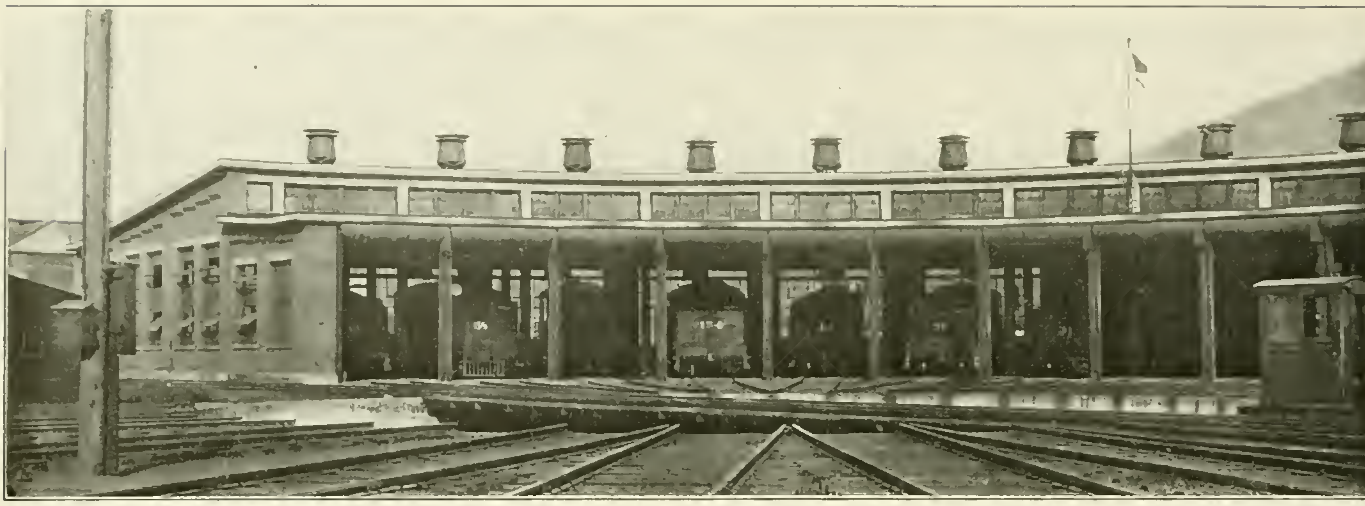
M. B. Morrow, Canmore Coal Company, Canmore, Alberta, addressed the association briefly during the closing session.

Association Business

The secretary-treasurer's report showed a gain of membership of 311 during the year with a total of 1,297. Owing to the increase in the cost of printing amendments to the constitution and by-laws were passed increasing the annual dues from three to four dollars.

The question of affiliation with the American Railroad Association was brought up and action was deferred till the next convention.

The following officers were elected for the ensuing year: President, J. B. Hurley, Wabash; vice-presidents, W. L. Robinson, Baltimore & Ohio, W. J. Bohan, Northern Pacific, and R. Bradley, Boston & Maine; executive committee: P. E. Bast, Delaware & Hudson; J. N. Clark, Southern Pacific; Robert Collett, New York Central; C. C. Higgins, St. Louis-San Francisco; J. M. Nicholson, Santa Fe; A. W. Perley, Oregon-Washington Railroad & Navigation, and T. Duff Smith, Grand Trunk Pacific.



Modern vs. Obsolete Engine Terminals

Advantages of Modernized vs. Antiquated Engine Terminals Considered from Many Different Angles

BY C. C. LANCE
Shop Engineer, Seaboard Air Line

DURING the past ten years the average size and weight of locomotives has increased from 25 to 30 per cent. In addition the complications brought about by the various specialties required on large modern locomotives, such as Power Reverse Gear, Stokers, Grate Shakers, Coal Pushers, Super-heaters, Headlight Dynamos, Automatic Fire Doors, Duplicate Air Pumps, of large size or cross compound, and the flexible steam and exhaust connections, intercepting valves, duplicate valve gears and other devices brought into use on articulated compounds, have greatly increased running repair and maintenance work. In fact, owing to the large size and weight of important parts and countless number of additional devices to require attention, that were comparatively unknown and unnecessary on small engines, the volume of work has increased in a larger proportion than the size of locomotives.

Increased tonnage and faster movement made possible by modern motive power have necessitated improvements in the physical condition of railroads that have been beneficial to operating and maintenance of way departments. Heavier rail and bridges, longer passing tracks, larger classification yards, reduction in grades and better roadbed have made it easier for the departments mentioned to care for their work although even these improvements have not kept pace with requirements and during Federal control were for the most part discontinued. The same consideration has not been given to the requirements of the mechanical department with the result that many roads are making vain effort to maintain heavy modern power at inadequate and obsolete terminals. Few modern engine terminals have been provided, except on some of the larger and far-sighted roads, and for the most part the terminals now being used to handle Mallet, Santa Fe, Mikado, and Heavy Pacific type engines were built from 20 to 25 years ago, when the largest engine was of the 10-wheel type. This is true of many important points handling from 500 to 900 engines per month. Spasmodic attempts have been made to modernize some of these old facilities by putting in 100-foot turntables and adding extensions to old roundhouses, but the fact remains that large power is still being handled with extreme difficulty in small crowded terminals where there is no possible opportunity to do more than makeshift repairs.

The Cost of Inadequate Engine Terminals

Annual improvement budgets are made up by most roads, giving in detail the needs of every department. The Mechanical Departments always bring up the question of adequate terminals showing the money justification and urging the provision of their minimum needs. For the most part discussion of these matters is closed with the statement that "they got by last year with what they had and ought to be able to run another year." Small consideration is given to the cost of handling power in obsolete terminals and its effect on future life and condition of engines. There are many terminal points that would be abandoned if a cost analysis was made which took into consideration the depreciation of power improperly maintained, the cost in road overtime due to poor work or terminal delays, fuel and labor expended standing engines on in and outbound tracks under steam on account of insufficient house room, ash pit facilities, etc.

At least one hour's time can be saved in the time required to make running repairs to each locomotive handled, considering that the average value of a locomotive in good working order is at least $50 per day, time saving of one hour would mean a gain of $2 per engine handled on account of increasing the total number of hours engines would be available in good working order. In addition to this on account of eliminating practice of mechanics attempting repair work on tracks outside of roundhouse, which naturally due to difficulty in handling materials and distance from tools increases cost of this work, a saving of at least one hour's time of one mechanic at 72c. per hour and one helper at 49 c. per hour or a total of $1.21 per engine will be made. This combined with the $2 time saving will amount to $3.21 saving per engine, and on an average of 50 engines per day the total annual saving will be $58,582.50. To this can be added a loss of $30,000 per annum which represents the actual cost of fuel burnt, and the time of engine watchmen that are required to keep up the fires of engines that are either waiting for vacancy in roundhouse or engines which have been removed from roundhouse in order to make room for others, and are kept under steam for unnecessarily long periods, waiting until they are called to take out trains. This makes a total annual saving of $88,582.50, which would result from

improved engine terminal facilities that would not cost over one million dollars, although the return assured on an investment of that magnitude would be almost nine per cent.

Obsolete Roundhouse Throws Burden on Back Shop

There are cases of old roundhouses having new and large turntables installed where the edge of pit is so close to front of house as to interfere with moving or handling of engines and preventing adjacent tracks being used for large engines on account of insufficient clearance. At some engine terminals the facilities are so inadequate that all trailer wheels removed, driving wheels dropped and similar work must be done in back shop under crane, taking up valuable engine pits and interfering with classified repairs. This, of course, can only occur at division shop points but would never occur at all if proper consideration to improvement needs had been given.

Generally roundhouses are low, smoky and in the South they are not provided with adequate heating facilities on account of the so-called short mild winters. In spite of the short mild winters referred to a surprising number of stoves are required and many instances of frozen piping and frozen up engines occur during at least five months of the year. The money wasted in fuel and attendance to stoves, thawing pipes and engines and highly paid mechanics loafing around stoves would in most cases pay for the installation of extensive heating systems and show a saving.

Some of the Improvements That Are Needed

The life of firebox, stay-bolts and boilers can always be prolonged by washing with hot water. Washing with cold water which must be done in order to get engines back into service promptly at points having no boiler washing plant is very injurious and causes leaky tubes, broken stay-bolts, cracks and other defects. There is a surprising lack of facilities for washing and filling boilers although it has been definitely proven that fuel is saved through filling boilers with hot water near the boiling point and by having clean sheets and tubes. The actual fuel saving due to filling boilers with hot water will amount to at least one-half to three-quarters of a ton of coal per engine handled, which would alone justify the expenditure, not considering the fuel savings made on account of clean tubes and sheets or the decrease in boiler repairs required and the saving in time required for washing boilers.

The machinery equipment at many roundhouse points has long been accumulated through the simple expedient of sending worn out and obsolete machinery no longer useful in main or division repair shops. This is a serious and expensive mistake and machinery of this character should be scrapped or otherwise disposed of. The roundhouse machine work must be done without delay, as in many cases there are no extra parts on hand and any manufacturing or fitting must be done accurately and promptly which cannot be done on worn out or broken down tools. Only the most modern machine tools should be installed and the small hand tools should be of good quality and furnished in such quantities as to avoid delay when more than one mechanic is required to do similar work. In old roundhouses handling heavy power delay and difficulty is usually experienced handling rods, cylinder heads, cross-heads, steam chests and other heavy parts by hand. Jib cranes have been put in for handling front cylinder heads and steam shafts, but overhead crane service should be provided in both roundhouses and shop to reduce the labor costs to a minimum.

Coaling and Ash Handling Facilities Require Particular Attention

The size, type and location of coaling and ash handling facilities contributes greatly to the successful operation of engine terminals. Many ash pits are the old style depressed track type that require deep pits and tracks supported on columns. These are hard to maintain and require large labor forces to handle cinders. In crowded yards this type of pit takes up much valuable room, on account of the approach to the depressed cinder loading tracks. Any type of cinder pit installed should provide for prompt mechanical removal of cinders and elimination of expensive hand labor, and delay to engines, pits having overhead crane service or bucket conveyors being preferable. Low first cost has generally been the consideration when erecting coal chutes and results in annoying and expensive delays when repairs are necessary account of poor design or light construction. Coal chutes should be provided with powerful rugged hoisting mechanism whether operated by steam or electricity, serving more than one track to eliminate all possible delay. Sand drying and delivering facilities should be arranged so coal and sand can be taken at the same time. There should be several water cranes located at the most convenient points.

A Comprehensive Plan Essential

I have endeavored to call attention to a few of the main features that will have to be remedied before efficient and economical operation can take place and power kept at its maximum efficiency. The longer the provision of adequate facilities is delayed, the greater will have to be the final expenditure. A comprehensive improvement program covering the requirements for the future as well as present needs should be mapped out by every railway and followed through to a conclusion. Care should be taken not to locate terminals where there is insufficient room for extension, thereby making it necessary to move to new location when extensions are required. Many improvements have been made in the past of light or semi-permanent construction—with an eye to economy in first cost. This is a serious error in judgment for buildings of this character soon deteriorate, are expensive to maintain, and in wet or cold weather work is interferred with and machinery and equipment damaged.

The most economical plan when providing facilities, taking into consideration all features, is to provide well planned and constructed facilities properly located, just a little larger than needed to care for immediate requirements, equipped with the best machinery and most up-to-date equipment obtainable. The execution of this plan will result in an actual money saving, a decrease in engine failures and terminal delays, prolonged life and increased efficiency of motive power.

FEDERATED AMERICAN ENGINEERING SOCIETIES

A total of 134 delegates, representing 66 engineering and other technical organizations, responded to the invitation of the Joint Conference Committee of the four founder societies to meet in Washington, D. C., on June 3 and 4. The result of this convention was the formation of The Federated American Engineering Societies, composed of societies and affiliations and not of individuals. The first action after the election of the chairman and secretary was the presentation of the following resolutions:

Resolved, that it is the sense of this convention that an organization be created to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions.

Resolved, that it is the sense of this convention that the proposed organization should be an organization of societies and affiliations and not of individuals.

The discussion which followed concentrated upon these resolutions. This brought forth a variety of opinions. The representatives of the American Association of Engineers, evidently believing that the new organization would possibly interfere with, or in some ways duplicate, their efforts in public welfare work, carefully sounded out the assembly on

the question of a society composed of individuals. Outside of the attention given the matter by this society the question of an organization composed of individuals received but little attention, the chief objection to it being the difficulty attending its promotion. The fact was brought out that practically all of the active members of the local and national societies were members of two or more organizations and that as such was the case there would be great difficulty in securing a membership large enough to promote and carry on the desired work.

With the sentiment in favor of an organization composed of societies and affiliations, the American Association of Engineers yielded its point and, joining with the rest, made the vote in favor of adopting the resolutions unanimous.

Constitution Is Adopted

The constitution, as presented at the second day's session, was finally adopted with a few minor changes and one addition, a publicity clause insuring the maximum co-operation with the press. In brief, the constitution provides for an organization to be composed of national, local, state and regional engineering and allied technical organizations. The management will be vested in a body known as the American Engineering Council and an executive board composed of 30 members of the council, including the president, the four vice-presidents and the treasurer of the council. Representation on the council will be on a basis of one member for the first 100 to 1,000 members of a society and one for every additional 1,000 or major portion thereof up to a maximum of 20. While it is in some measure true that this plan would give the nationals too large a relative representation it was shown that the affairs of the nationals and the locals were so closely allied and the memberships of the two were so closely interwoven that in reality it would make but slight difference. Members of the executive board will be elected by districts, the proportion being the same as on the council.

Funds for the financing of the new organization will be provided by contributions from each member-society equal to $1.50 per member for the national and $1 per person for the local, state and regional organizations. Several local societies objected to this on the basis that a large part of their membership consisted of non-voting members paying small dues and that the tax would be out of proportion.

Under the circumstances the constitution was interpreted to read that as each organization must submit its constitution and by-laws to the executive board before becoming a member, it could at that time submit a statement showing the number of voting members or members upon which it wished its representation based. The board would then be in a position to judge fairly and to decide in each case what would be equitable.

Provision was made for co-operation with and the encouraging of local, state and regional organizations in the formation of affiliations for the purpose of considering public welfare matters. In inserting a publicity clause, a provision was made for the formation of a publicity committee and in order to further their work all meetings, except executive sessions of the board, were to be open meetings, and the books and minutes of the organization were to be open for transcription at any time.

The constitution and by-laws were adopted by the conference by a unanimous vote of all voting, although several societies refrained from casting a vote, even though it was understood by all present that any decision made by a delegate was not binding upon his society. The largest organization not voting was the American Association of Engineers, whose representatives refrained from voting on the basis that as they disagreed with certain sections of the constitution they did not feel at liberty to ratify it. They did wish, however, to assure the conference of their sincere intention to co-operate to the best of their ability and along such lines as the Federated American Engineering Societies would formulate, leaving the question of ratification to a vote of the association itself.

The only delegation present with full power to accept or refuse any action of the conference was that of the American Society of Mechanical Engineers, who ratified the constitution in the name of that society. The representatives of this society further stated that the society was ready to enter the federated societies at any or such time as the latter found convenient to handle such work.

Significance of the Federation

A study of the constitution adopted reveals the underlying significance of the federation and outlines in some measure the scope of its future activities. The following statement from Article II of this document is worthy of note:

Service to others is the expression of the highest motive to which men can respond, and duty to contribute to the public welfare demands the best efforts that men can put forth; therefore, it shall be the object of this organization to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions.

In this paragraph is revealed a splendid appreciation of responsibilities of the engineering profession to the public welfare. The engineering profession today exercises a greater control over those forces of nature that affect our material welfare than any other profession; although the youngest, it has acquired in a brief space of time the greatest potentialities for doing good. The organization of this federation is, in fact, a belated appreciation of the dignity and power of the profession as a whole, and a desire to put into concrete form an expression of the ideals of the engineer.

In this movement the engineer both sacrifices and gains something affecting his personal interests. Affiliation with the federation represents a subordination of the purely personal objectives to the public good, but at the same time the engineer has gained much. The federation should go a long way towards dignifying the profession and towards commanding the respect of all other interests. It should tend to put the engineering profession in its proper plane and to put the individual engineer in a position where he cannot be exploited.

Federation and the Railroads

The formation of this important federation should mean something to men of the engineering profession in railroad service. While a few engineers have made a brilliant success out of a railroad career, the profession has not as a whole fared favorably at the hands of the railroads, and this in turn has reacted unfavorably on the railroads themselves, until we have a situation in which but relatively few young engineers are engaging in railroad employ.

Railroad work should afford a splendid opportunity for the engineer, its technical problems are immense and it has been demonstrated that the trained engineer often makes a most proficient executive in the operating as well as the technical field. It is not too much to say that the engineering profession affords the best if not the only salvation for the railroads in their endeavor to perform a great public service with insufficient and inefficient equipment. The Federated American Engineering Societies can do much towards improving the standards of remuneration for engineers and towards creating appreciation of the value of engineering service; it can also point out the engineer's responsibility to the public and public service in which the railroads must figure prominently.

CAR DEPARTMENT

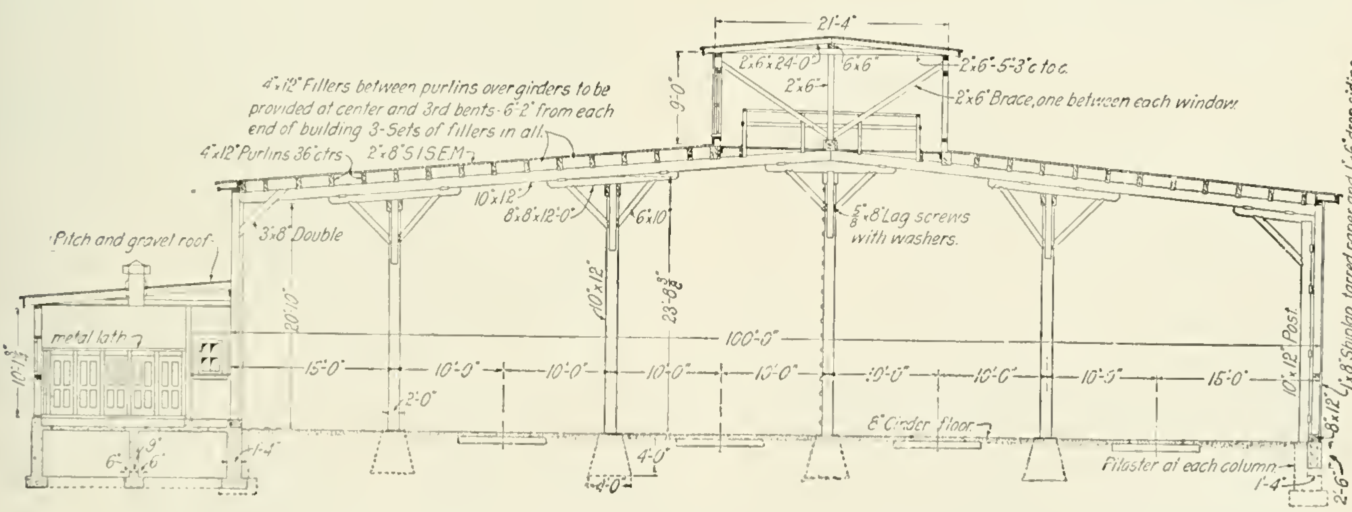
TWO ADDITIONAL STATES REQUIRE CAR REPAIR SHEDS

Recent statutes passed by the states of Minnesota and North Dakota require railroads or other concerns doing car repairing to provide suitable houses so that the men engaged in this work are protected from the weather. The Minnesota law requires that such buildings shall be constructed wherever there are six men engaged at one time in the repairing of cars, car trucks, etc., while in North Dakota the minimum is five men. Exception is made in the case of repairs to cars while they are en route as part of a train.

The Minnesota law goes into minute detail as to the character of the building and leaves very little of the design to be determined by the railway company's architects or engineers. The specifications as given in the statute are as follows:

"In buildings that cover more than one track the distance between the inside rails of each track shall not be less than 12 ft. Between the walls of the building and the outside rails there shall be a distance of 10 ft. The building or buildings shall not be less than 20 ft. high at the eaves. Each building shall be enclosed from roof to ground and shall have glass windows on each side not to exceed 12 ft. apart. The side windows shall not be less than 9 ft. high and not less than 4 ft. wide. Windows shall be in three sections and each section shall be equipped with pivot and opening device. The buildings shall be equipped with side and end doors. The end doors shall be not less than 6 ft. wide and 15 ft. high, and there shall be two such doors for each track covered by the building. The side doors shall be the same width and height as the end doors and shall be not to exceed 40 ft. apart. The roof shall be provided with a cupola the entire length of the building and be equipped with side windows of not less than 3 ft. in width and 6 ft. in height, having pivot and opening device that shall be at all times operative. A similar cupola shall be provided for each two additional tracks in width of such building.

"The buildings shall be equipped with necessary heating facilities and shall at all times have drainage that will keep them in a clean and sanitary condition. They shall be equipped with sanitary drinking fountains where clean, wholesome drinking water can be obtained. A sufficient number of sanitary lavatories shall be provided for said employees. Such toilets shall be properly partitioned and there shall be at least one for each 15 persons employed. All scaffolding used in such buildings shall be made of clear lumber free of all knots and shall be kept in first-class



Car Repair Shed Designed by Northern Pacific to Meet Requirements of Minnesota Law

condition at all times. The use of paint spraying machines shall not be permitted inside such buildings."

The execution of the law is imposed on the Railroad & Warehouse Commission of Minnesota, which shall determine as soon as practical where and what buildings are to be built by the railroads and issue orders accordingly. Penalty for failure to comply with the provisions of the statute is a fine of not less than $100 or more than $500 for each offense, and each day or part of the day that failure continues constitutes a separate offense.

The manner in which railroads are complying with these statutes is indicated by the drawing of a structure designed by the Northern Pacific for construction at Watertown, N. D. This is a frame shed, 100 ft. by 250 ft., supported by 10-in. by 12-in. posts and spaced 20 ft. center to center transversely, and 21 ft. longitudinally. The roof consists of 2-in. by 8-in. planks carried on 4-in. by 12-in. purlines and covered with pitch and gravel roofing. The walls are composed of a layer of 1-in. by 8-in. shiplap covered by 1-in. by 6-in. drop-siding with tarred paper between. The foundations are of concrete and the floor of cinders. Tracks are provided at 20-ft. centers. The monitor is 21 ft. wide by 9 ft. high and is equipped with corrugated iron curtain walls at intervals of about 62 ft. as barriers to spreading fires. Toilet facilities are provided in a lean-to 18 ft. by 22 ft. in the middle of one side.

AIR PRESSES DESIGNED FOR CAR SHOP AND RECLAMATION WORK

BY F. S. TINDER
Material Inspector, Virginian Railway

Two air presses built for the reclamation department and car smith shop of the Virginian Railway have proved of considerable value in facilitating both reclamation and repair work, and their use has resulted in important savings of material and money. The double action press illustrated in Fig. 1 was developed for use in the reclamation department and has been kept busy straightening bent shanks and resetting guard arms of car couplers, straightening angle and channel iron, flanged sheets for pressed steel cars, and other

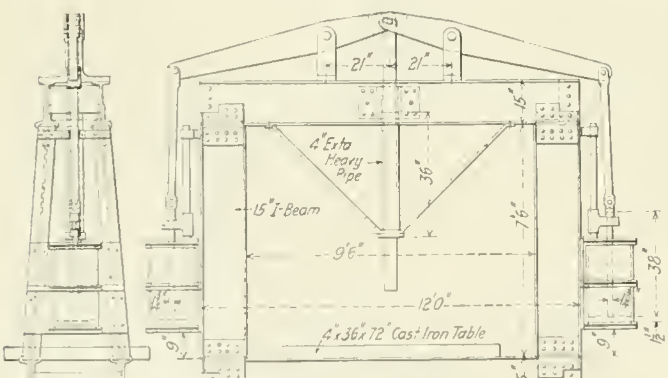


Fig. 1—Double Action Air Press for Reclamation Work

miscellaneous work. It is also used to great advantage in straightening and reflanging pressed steel car parts, as this material is best straightened cold. By the use of suitable dies on this machine, such miscellaneous articles as truss rods for brake beams, corner angles, sill steps, etc., can be formed and bent.

The machine is built mostly of second-hand material, the 15-in. I-beams used for the frame being removed from old bridges. Second-hand 14-in. by 12-in. air brake cylinders were used, two of these cylinders being bolted together and rebored for each side of the press. As indicated in the illustration, a guide and crosshead is provided for the piston and through the operation of suitable levers, the plunger is forced down against a cast iron table on which the work is placed. The entire framework of the press is substantial and rigidly connected. The plunger is held in a vertical position by a supporting guide made of 4-in. heavy pipe, rigidly held in place. It is possible to obtain a working pressure of approximately 50 tons with this press.

The air press developed for blacksmith shop use, shown in Fig. 2, is built of the same material as the double action press previously described. The construction and operation of this press is quite plainly indicated in the sketch and will develop practically one-half the pressure of the double ac-

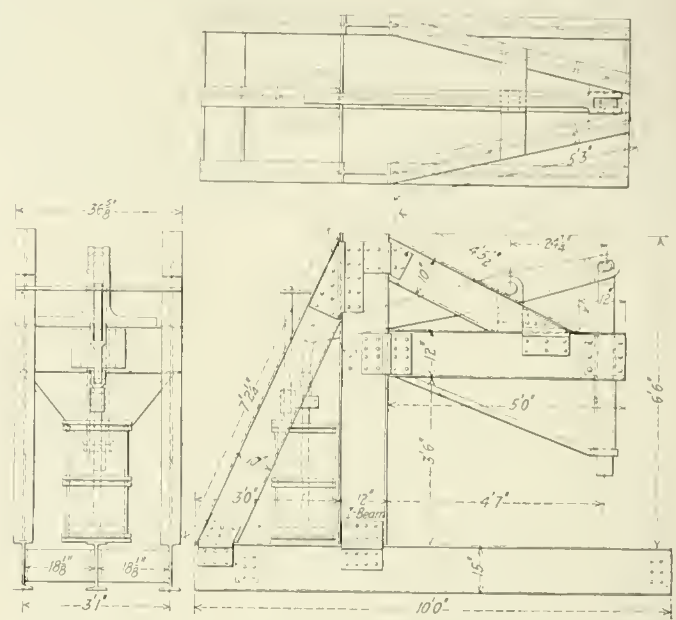


Fig. 2—Single Action Air Press for Car Shop Work

tion press. An additional advantage, however, consists in the fact that one side is open. This makes it possible to handle large sheets and odd shaped material. The press is used for straightening and forming various car parts.

The valve operating both of these air presses consists of an operating seat and stem used with the top case of an H-6 Westinghouse brake valve, the two important positions of the handle being application and release. The ordinary designs of air presses with a large cylinder acting directly on the ram are not only wasteful of air but also make it difficult to use sledges for straightening sheets while held in the press. These presses are economical in operation, easy to make and will be found important adjuncts to facilitate work in both the reclamation department and car blacksmith shops.

How an Engineer Got Rich.—We have just learned of an engineer who started poor 20 years ago and has retired with the comfortable fortune of $50,000. This money was acquired through industry, economy, conscientious efforts to give full value, indomitable perseverance and the death of an uncle who left the engineer $49,999.50.—*Official Bulletin, Colorado Society of Engineers.*

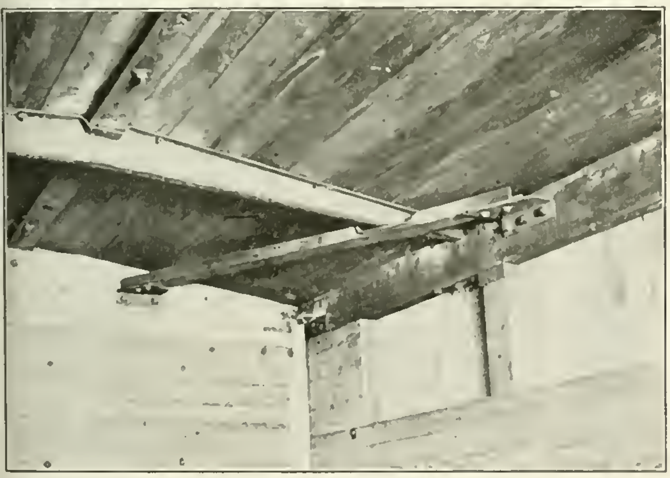
Heat Treatment Oils.—The essential requirements of tempering oils are: flash and fire tests high enough to avoid serious evaporation loss or to incur high fire risk, comparative freedom from decomposition, absence of acid or acid forming substances, which would have a materially corrosive action on metals at high temperature, a fairly high heat capacity, and enough fluidity to permit rapid carrying-away of the heat.—*The Atlantic Lubricator.*

The Freight Car Shop at Elizabethport

Car Repairs at Elizabethport Shops

Interesting Features of the Work Done at the Principal Plant on the Central Railroad of New Jersey

THE Elizabethport shops of the Central Railroad of New Jersey are the largest car shops of that road, having a capacity of about 4,000 cars a month. The great variety of work done at this plant involves some interesting and novel practices. The account which follows is intended not as a comprehensive description of the shop practices,



Bracing Applied to Corners of Box Cars

but rather as a few notes on methods used for facilitating the work, for eliminating maintenance troubles and for securing improved service from the equipment.

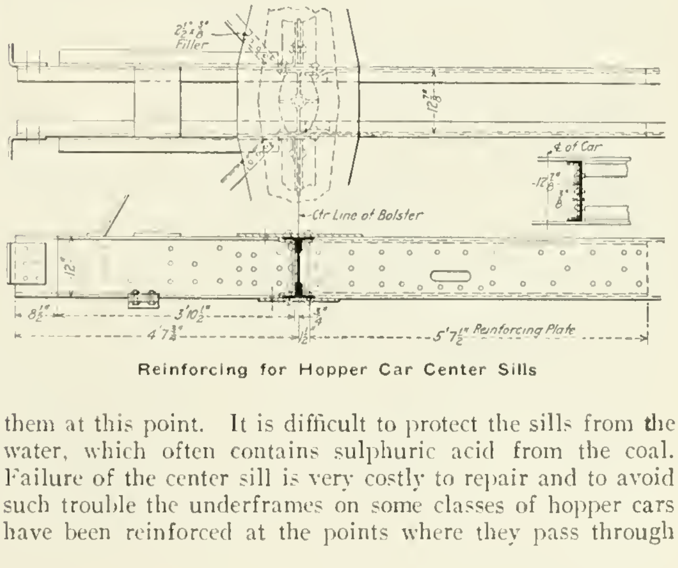
Reinforcing Wooden Cars

In cars with wooden superstructure it has been found that the weaving of the body loosens the sheathing and lining and causes the car to leak. This action is particularly noticeable near the ends, and to overcome it the corners of cars passing through the shops are being strengthened by the application of diagonal braces. These braces, as shown in the illustration, are made of 4-in. by 1-in. channels, or of 3-in. by $\frac{3}{8}$-in. bars, with an angle of $\frac{1}{4}$-in. plate riveted to each end. One brace is used in each of the four corners, being bolted to the side plate and the end plate.

On some of the wooden box cars of 60,000 lb. capacity steel center sills are being applied in connection with transom draft gear and friction springs. The center sill reinforcing consists of 9-in., 15-lb. channels, spaced $9\frac{1}{2}$-in. back to back, with the flanges extending over the wooden center sills, to which the channels are bolted every two feet. Stop plates are riveted between the channels and to these in turn are fastened the bolsters. In order to give additional strength to the section of the center sill between the bolsters the two sills are tied together with $\frac{3}{4}$-in. bolts and 1-in. pipe thimbles. The end sill is reinforced by a 10-in. channel.

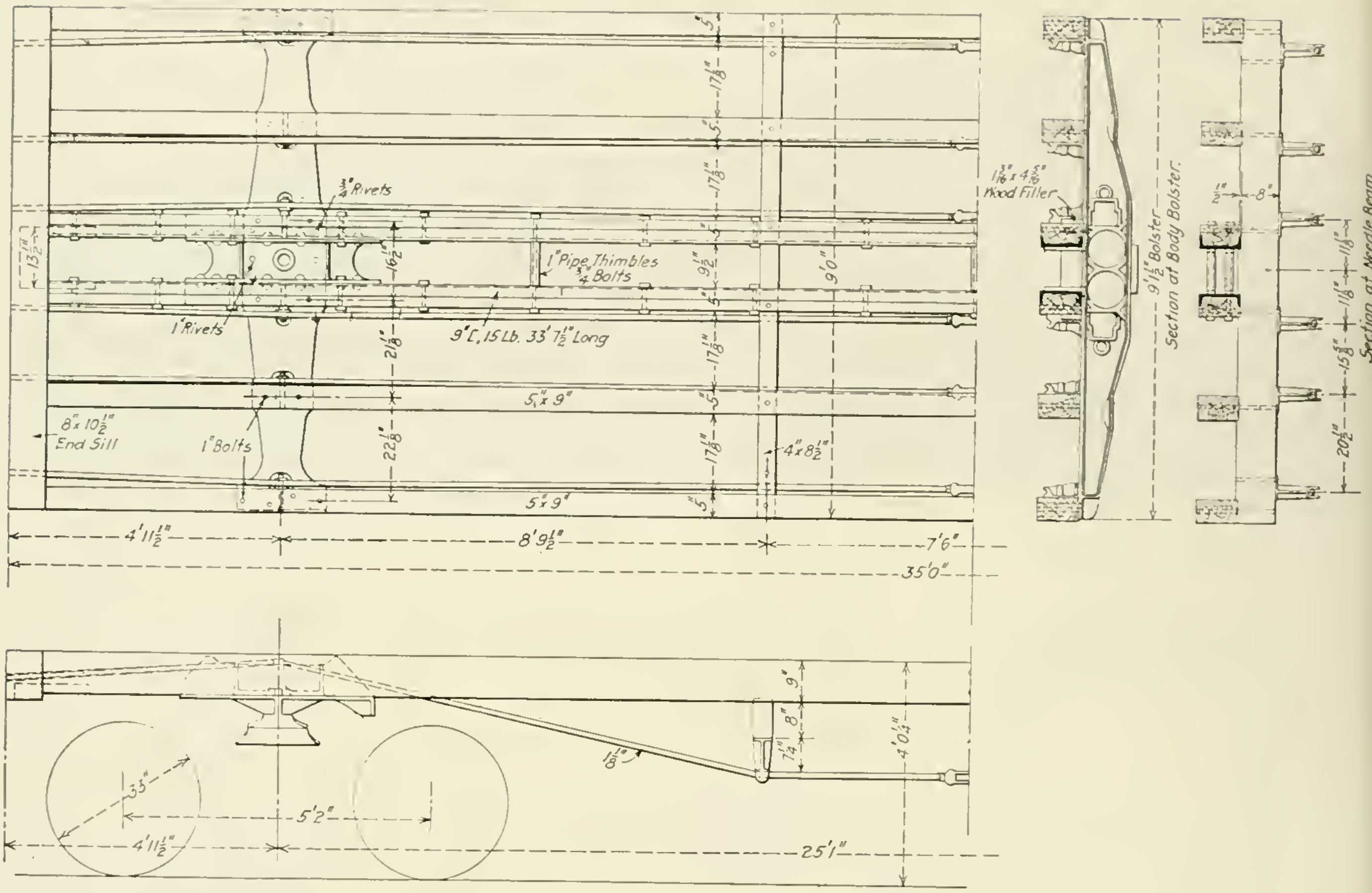
Reinforcing Center Sills on Coal Cars

Hopper cars used for coal traffic often give trouble due to the center sills buckling a short distance beyond the bolster. The cause of such failures is usually excessive corrosion of the sills resulting from the moisture that drips upon

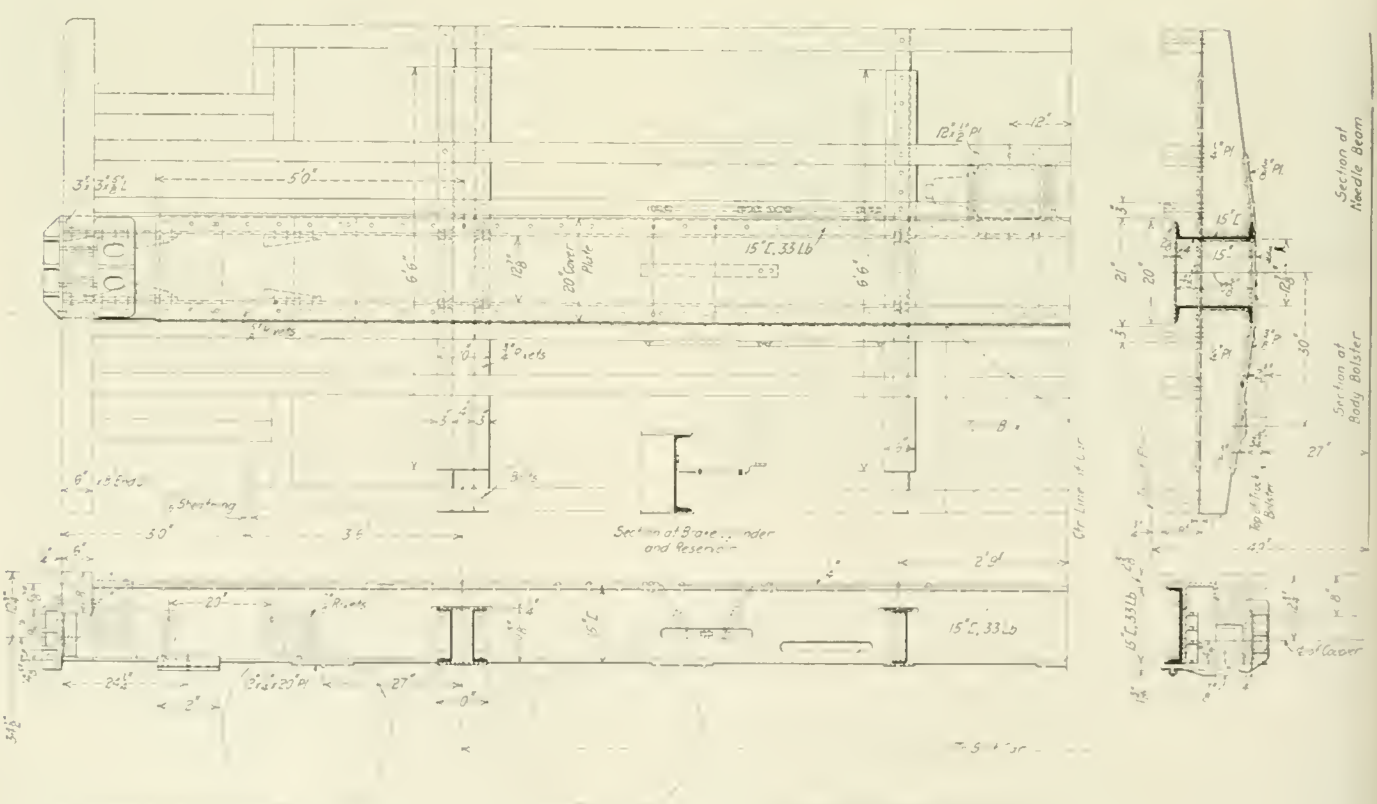


Reinforcing for Hopper Car Center Sills

them at this point. It is difficult to protect the sills from the water, which often contains sulphuric acid from the coal. Failure of the center sill is very costly to repair and to avoid such trouble the underframes on some classes of hopper cars have been reinforced at the points where they pass through



Reinforcing for 60,000-lb. Capacity Box Cars

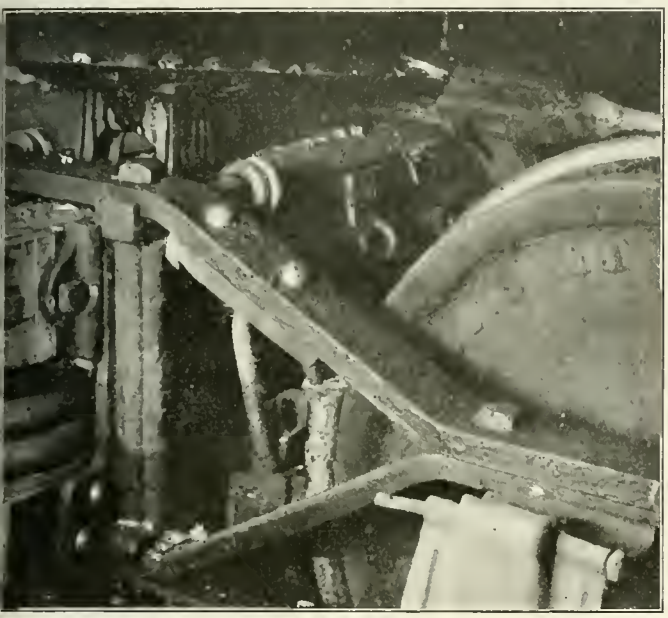


Steel Underframe Applied to Caboose Cars

the hopper. This reinforcing consists of 3/8-in. plates, 5 ft. 7 1/2 in. long, flanged to fit between the flanges of the center sill channels as shown in the drawing.

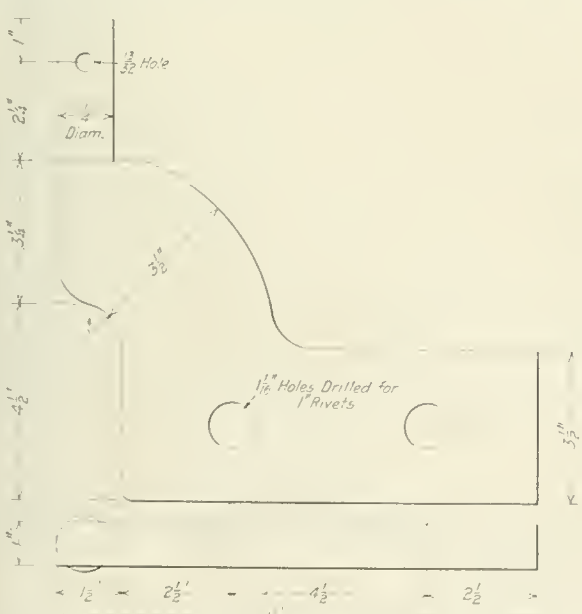
Steel Underframes for Cabooses

In order to make wooden cabooses suitable for modern service, the Central Railroad of New Jersey is fitting this



Bracket for Inside Hung Brake Beams Riveted to Arch Bar

class of equipment with steel underframes which are constructed at Elizabethport shop. The details of the underframes have been standardized. The center sills are made up of two 15-in., 35-lb. channels, continuous from end to



Details of the Brake Hanger Bracket

end. The center line of draft is 4 5/8-in. from the lower flanges and the upper flanges and web plates are notched to receive the 6-in. by 8-in. end sill, which fits between the striking plate and a filler casting. A cover plate 1/4-in. thick and 20 in. wide extends 5 ft. beyond the bolsters.

The body bolsters are of channel section, pressed from 1/4 in. steel plate. Pressed steel fillers are also used between the center sills at the bolsters. The web plates are spaced four inches apart and fit against the lower flange of the center sill. The top cover plate 10-in. wide, 1/4-in. thick and 6-ft. 6-in. long, passes through slots cut in the sills. The bottom cover plate is 3/8-in. by 10-in. by 6-ft. 6-in. and extends under the body bolster. Cast steel center plates and pressed side bearings are used.

The needle beams have web plates of one pressed section identical with those used in the bolsters. The fillers between the channels are also the same. The top cover plates are 1/4-in. by 6-in. by 6-ft. 6-in., while the bottom plates are 3/8-in. by 6-in. by 4ft. 0-in. Cross braces are riveted to the bottom flange of the center sills at the center line of the car midway between the needle beams and bolster and 2-ft. 3-in. outside the bolster. These underframes are fitted to receive Miner A-18 friction draft gear.

A Simple Uncoupling Arrangement

The Central Railroad of New Jersey is now applying to a large number of cars a simple uncoupling arrangement of rugged design, which does away with chains and clevises. The end of the uncoupling lever is bent to form an elon-

Uncoupling Mechanism in Lock Set Position

gated eye. The link for attachment to the coupler lock is a simple piece made in the forging machine from 5/8-in. round stock. A half round head is formed on one end and the eye on the other end is bent partly shut. This eye is slipped through the opening in the uncoupling lever and is closed after the end is passed through the eye in the coupler lock. The freedom of action secured by this arrangement is clearly shown in the drawing.

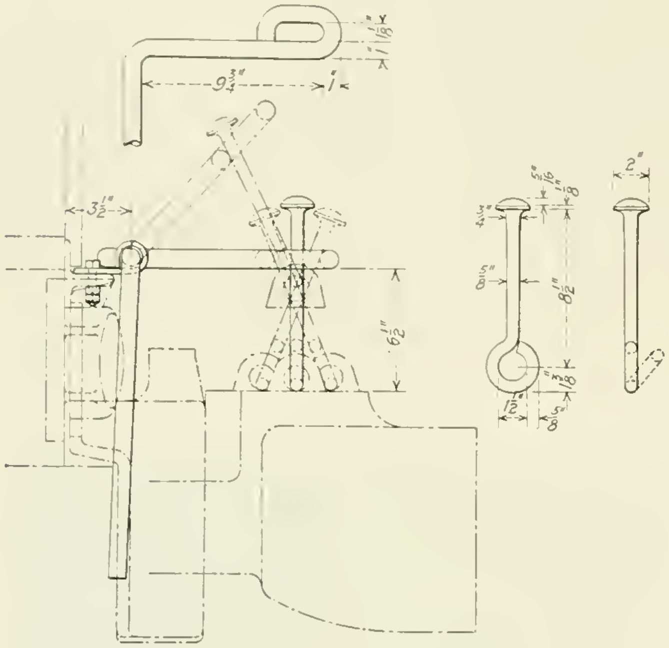
Applying Inside Hung Brake Beams on Caboose Car Trucks

On some of the lighter arch bar trucks which do not warrant extensive remodeling, a simple method has been adopted for applying inside hung brake beams. A forged bracket to support the brake beam is riveted to the top arch bar, as shown in the photograph. This does away with the necessity for changing the column posts or even removing the column bolts. As the arch bar is in compression the rivet holes are not objectionable and the bracket gives additional strength.

Cleaning Passenger Trucks

The labor involved in cleaning passenger trucks has been greatly reduced by using a spray for removing the lye clean-

ing solution. Water alone would not give satisfactory results in washing off the compound. A combining nozzle was made in which the water is introduced into a jet of air, forming a heavy spray. This has sufficient force to clean



Details of Uncoupling Arrangement Showing Wide Range of Action

the lye from the parts. It is also used for washing down the sides of cars and by attaching it to a tank it can be employed for whitewashing.

Winch for Hauling Cars

Steel cars passing through Elizabethport shop and in need of general repainting are thoroughly sand blasted before the paint is applied. As the sand blast building is only 90 ft.

Hauling a Cut of Cars with the Electric Winch

long the cars must be pulled out at frequent intervals. To avoid tying up a switch engine for this work an electrically operated three-ton Sprague winch has been installed just outside the building. A block is also attached at the entrance to the paint shop and by means of a rope the cars can be hauled in either direction.

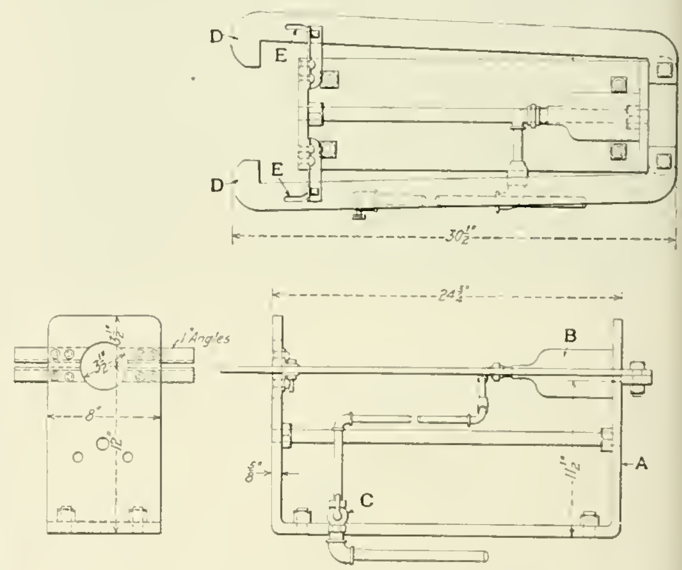
There is just one way to force prices down under present conditions—that is for all of us to pitch in and produce so much of everything that at the same time prices can and must go down. Cut the cost and boost the supply and prices must drop. But as long as we go on cutting the supply and boosting the cost by loafing on our jobs, prices will hold their upward course.—*Saturday Evening Post.*

PNEUMATIC CLAMP FOR TRIPLE VALVES

By T. H. Birch
Air Brake Foreman, Chicago, Milwaukee & St. Paul

Many triple valves come to the car shop for repairs and if only a few minutes can be saved on each valve the total saving of time in the course of a year will be considerable. One way in which this time has been saved at the Milwaukee shops of the Chicago, Milwaukee & St. Paul has been by the construction and installation of a device which clamps triple valves quickly and holds them during the operation of cleaning and repairing. Formerly an ordinary vise was used for this purpose, but the contour of the check valve case made it somewhat difficult to hold the valve firmly, and in addition the valve was not in the most convenient position for repair work.

Adapting the clamping principle of the triple valve test rack the device, illustrated, was made and proved very successful for this work. Referring to the illustration, the de-



Clamp for Holding Triple Valves While Being Repaired

vice which is of simple construction consists of a bracket *A* made of 5/8-in. iron, bent up at the end and bolted to the repair bench as shown. This bracket is stiffened by two rods and supports a K-1 slack adjuster cylinder *B*, as shown. This cylinder is operated by air through the operating valve *C*, and when the air is turned on clamping arms *DD* are moved in such a way as to hold the triple valve firmly against the bracket. When the cylinder piston starts to move the clamping arms approach the bracket and come together, being guided by the slots *EE*. The operation of the clamp will be evident from an inspection of the illustration.

For any car shop repairing a considerable number of valves, this triple valve clamp will more than pay for the cost of its construction by the saving in time effected by means of its use.

Metric System Condemned.—In addition to the recent order of Secretary of War Baker directing the discontinuance of the use of the metric system, the Navy Department also, through prominent officers, has expressed its opposition to that system.

Refrigerator Cars.—There are approximately 115,000 freight refrigerator cars and 1,650 express refrigerator cars in service at the present time. Thirty thousand of the freight cars are owned by private car lines, while 250 of the express refrigerator cars are owned by the American Railway Express.

THE INSPECTION OF FREIGHT EQUIPMENT*

Handling and Testing Tank Cars; Regulations Governing Interchange; Billing for Foreign Repairs

BY L. K. SILLCOX
Assistant General Superintendent Motive Power, Chicago, Milwaukee & St. Paul

THE rules of the American Railroad Association, Mechanical Section, cover Standard Specifications for Tank Cars and schedules for testing tanks and tank safety valves. Extracts from sections of the rules relating to the handling of this equipment are given below.

Transportation requirements. (c) A tank which does not meet the prescribed tests shall be withdrawn from transportation service.

Tests

22. *Certification of Tests*: Tests of all tanks and their safety valves shall be certified by the party making the tests to the owner of the tank car and to the Chief Inspector, Bureau of Explosives, in the form prescribed by the bureau.

23. *Tests of Tanks,* CLASS I. Tanks shall be tested at intervals of not over five years.

CLASSES II AND III. Tanks shall be tested before being put into service, again at the expiration of ten years, and after that at intervals of not over five years; with the exception that where tanks are used for the transportation of such corrosive products that deterioration is to be expected in a shorter time, the first test for such tanks shall be reduced to five years. Tanks requiring this five year test shall be those used for the transportation of chemicals such as acids, ammonia, liquors, etc., and such other products as may hereafter be specified.

CLASS IV. Tanks shall be tested before being put into service, and after that at intervals of not over five years.

CLASS V. Tanks shall be tested before being put into service, and after that at intervals of not over two years.

CLASSES I, II, III AND IV. Any tank damaged to the extent of requiring patching or renewal of one or more sheets, or extensive reriveting or recalking of seams, shall be retested before being returned to service.

CLASS V. Any tank damaged to the extent of requiring patching or renewal of one or more sheets shall be retested before being returned to service.

*Seventh of a series of articles on this subject by Mr. Sillcox, copyright 1920 by the Simmonds-Boardman Publishing Co.

Tanks shall be tested to the following pressures:

Class I	Either 40 or 60 lb. per sq. in.
Class II	Either 40 or 60 lb. per sq. in.
Class III	60 lb. per sq. in.
Class IV	75 lb. per sq. in.
Class V	300 lb. per sq. in.

CLASSES I, II, III and IV. All tests shall be made by completely filling the tank with water, or other approved liquid safe to use, of a temperature which shall not exceed 70 deg. F. during the tests, and apply the pressure in any suitable manner. The tank shall hold the prescribed pressure for not less than ten minutes without leak or evidence of distress after the tank has been calked tight.

CLASS V. The tank shall hold the prescribed pressure for not less than 30 minutes without any leak whatever. Calking to stop leaks developed during the test will not be permitted.

ALL CLASSES. When tanks are tested, the date, pressure to which tested, place where test was made, and by whom, shall be stencilled on the tank in accordance with the Master Car Builders' standard marking for freight cars.

24. *Test of Safety Valves.* CLASSES I, II, III and IV. Safety valves shall be tested at intervals of not over two years, those on new cars being tested before the cars are placed in service.

CLASS IV. At intervals of not over six months.

CLASSES I, II, III and IV. The test may be made without the removal of the valve from the car, provided the valve unseats at a total pressure corresponding with the area of the seat multiplied by the required pressure.

ALL CLASSES. When valves are tested, the date, pressure to which tested, place where test was made, and by whom, shall be stencilled on the tank in accordance with Master Car Builders' standard marking for freight cars.

20. The pressure to which valves shall be set are prescribed in Section 20 of each specification and are:

CLASSES I and II. Products with flash point below 20 deg. F., valves shall be set at 25 lb. per sq. in. Products

with flash point 20 deg. to 150 deg. F., valves may be set to 12 lb. per sq. in.

CLASS III. Valves shall be set at 25 lb.
CLASS IV. Valves shall be set at 25 lb.
CLASS V. Valves shall be set at 200 lb.

The tolerance above or below the specified pressure is one pound for the 12-lb. setting; three pounds for the 25-lb. setting and five pounds for the 200-lb setting.

Apparatus for setting safety valves in place on cars should be furnished at the principal repair points. These devices should be made up in accordance with the specification for tank cars, a copy of which must be in the hands of each car foreman.

Interstate Commerce Commission Tank Car Regulations

1822, (g) Tests of all tank cars and their safety valves, as made in compliance with Master Car Builders' rules, must be certified by the party making the tests to the owner of the tank car and to the chief inspector, Bureau of Explosives; and this certification must show the initials and number of the tank car, the service for which it is suitable, the date of test, place of test and by whom made.

1824, (j) After May 1, 1915, a tank car must not be used for shipping inflammable liquids with flash point lower than 20 deg. F., unless it has been tested with cold water of 60 lb. per sq. in. pressure and stencilled as required by Master Car Builders' rules.

Note. For casinghead gasoline, blended or unblended with other products, and with vapor tension not exceeding 10 lb., tank cars, 60 lb. test class, must have safety valves set to operate at 25 lb. per sq. in., and provided with "fool proof" dome covers (see amended paragraph 1824 (k), effective May 15, 1916).

For all other liquids with flash points lower than 20 deg. F., safety valves must be set to operate at 25 lb. and "fool proof" dome covers must be provided not later than July 1, 1917 (see amended paragraph 1825 (k), effective July 1, 1917),

The above instructions are taken from the Standard Specification for tank cars. It is important that each car foreman familiarize himself with the specification for tank cars, and especially the instructions pertaining to the testing of tanks and the safety valves. As stated above, certain points should be equipped with the apparatus for testing valves on cars, the object being to equip only the more important interchange points, so that cars can be tested before being delivered in interchange, when the date of the last test requires that retest be made. All points having equipment to test safety valves should make the report on B. E. form 17-B, Certification of Test, to cover each car tested.

Leaky Tank Cars.—In cases where tank cars are transferred due to leakage and no repairs made, they should be stencilled on each side "Leaky tank; do not load until repaired."

Outlet Valves and Dome Caps on Tank Cars

Tank cars enroute should never be allowed to proceed with tank outlet valve caps dangling from retaining chains, since they break off and are lost in this manner. In some instances, employees have been found opening outlet valves on the bottom of empty tank cars which have been loaded with gasoline or other oils, to drain them. This is a very dangerous practice and should not be permitted. In the same manner dome caps are to be properly secured and in place at all times.

Hooks for Refrigerator Car Doors

Refrigerator cars not equipped with door hooks and fasteners to secure the doors in an open position will not be accepted in interchange.

Stake Pockets for Flat Cars

It is desirable and necessary for flat cars used in commercial service to have side stake pockets spaced 24 in. minimum and 42 in. maximum. System cars are to be equipped as fast as possible with bent plate type stake pockets secured by either bolts or rivets and inside washer bearing plate.

Temporary Running Boards

When it is necessary to provide temporary running boards and hand rails to well-hole cars and those not equipped with roofs or running boards to make the equipment safe for trainmen, the cost is chargeable to the owner in cases where owners are responsible for the defective condition. The cost of applying temporary hand railings to, or boarding over the openings on empty well-hole cars, is also chargeable to the car owner.

General Handling of Interchange

If a car has defects for which the owners are not responsible, the receiving line shall require that a defect card be securely attached to the car. Defect cards shall not be required for any damage so slight that no repairs are required, nor for raked or cornered sheathing, roof boards, fascia, or bent or cornered end sills, not necessitating the shopping of the car.

At outlying points where joint inspection is not in effect, the matter will be left to the judgment of the receiving line. Where chief joint interchange inspectors are employed, the decision will be made by the chief interchange inspector.

Defect cards shall not be required for missing material in fair usage from cars offered in interchange. Neither shall they be required of the delivering company for improper repairs that were not made by it.

Defect cards must be of the form prescribed by standard instructions. They must be of cardboard, printed in red ink on both sides, and must be filled in on both sides with ink or black indelible pencil. The cards must plainly specify in full each item for which charges are authorized, indicating the location of defects.

To justify bill, repairs authorized by defect cards must be made within two years from date of first receipt of car on home line, except wrong repairs, which must be corrected within nine months from date of first receipt of car on home line.

Any road making partial repairs of defects on a car which are covered by a defect card will have the defects repaired crossed off the original card with ink or indelible pencil and the card replaced on the car. A copy of the card accompanying the bill with the defects which were not repaired crossed off will be sufficient authority to bill.

Original Record of Repairs

When repairs are made to a foreign car (except as otherwise provided) or to any car on the authority of a defect card, a form shall be used for the original record of repairs, from which the billing repair card shall be made. This form embodies the minimum information required for the proper preparation of billing repair cards. Additions may be made to this form and its size made to suit the requirements of any company. This original record of repairs may be in book form if so desired.

A card similar to the above in its essential requirements, upon which repairs to more than one car may be recorded, may be used for recording minor repairs made in transportation yards.

In recording repairs upon the original record the following requirements must be observed:

(1) Cars shopped for repairs must be carefully inspected by an authorized person before the work of repairing is begun, and all work authorized by him must be entered upon the original record, including the location of each item of repairs and the exact reason or cause for making repairs. This information must not be assumed, but must be deter-

mined by an actual inspection. The common terms "broken," "bent," "missing," etc., if used, when caused by wreck, derailment, cornering, sideswiping or other causes must be qualified to show such cause.

(2) Special care must be taken to obtain a correct account of the material actually used. The finished sizes of lumber as applied to the car must be shown on the original record; feet, board measure need not be shown. The number and size of bolts, and the purpose for which they are used, must be shown upon the original record; the weights need not be shown. Nuts must be specified, except those used on bolts renewed, in which case an average of one nut per bolt will be assumed as used, regardless of whether double nuts are used.

The actual weight of forgings, structural or pressed steel shapes and weight and kind of castings must be shown on the original record in the space provided, except where the weight is accurately determined by definite description. Paint and nails must be shown on the original record; the quantity need not be shown in those cases where it can be properly determined by the billing clerks.

(3) All items carrying labor charges must be covered in proper detail on the original record; the time or money charges need not be shown. For items of labor computed on the rivet basis, the number and diameter of rivets must be shown on the original record. For items of labor for straightening or repairing, computed upon the weight basis, the weight of material must be shown on the original record.

(4) The original record must be signed by the authorized person making the original inspection and the person making the complete inspection or by other authorized person making the original record, to vouch for its correctness. The original records covering minor repairs made in transportation yards must be signed by either the person inspecting the repairs or the workman who repairs the car. All corrections made on the original record must be made by the person or persons who have vouched for the correctness of the original record by their signature.

Billing Work on Foreign Cars

These original records must be kept on file, for ready reference, preferably either at the point where repairs are made or the point at which they may be stored in accordance with local regulations. The billing repair cards must check with the original record of repairs, in so far as they should properly check as regards to details charges.

When repairs of any kind are made to foreign cars a billing repair card must be furnished the car owner, except as otherwise provided. This card must specify fully the repairs made, the reason for same, the date and place where made and the name of the road making repairs, and must also show the location of parts repaired or renewed.

When repairs are made to any car on authority of a defect card issued by other than the owner of the car, in addition to the billing repair card furnished the car owner, a separate billing repair card must accompany the defect card. This separate billing repair card must show the repairs made, details of charges, date and place where repairs were made; also references to the name or initial of the road issuing the defect card and the date issued.

If no bill is to be rendered, the billing repair card must be attached to the monthly bill, with the words "no bill" written across the face of the card, in which case the cards must be entered in the billing statement in the first four columns, with the notation "no bill" in the fifth column for reference.

The billing repair card shall be made in duplicate, the original to be known as the billing repair card and the duplicate to be known as the record repair card and to be of the forms prescribed, all items of repairs to be in handwriting or typewriting.

The following information must be specified on billing repair cards:

MCB couplers or parts thereof, R and R	New or second hand. Size of shank. Where 12¼ in. head coupler or type D coupler is removed or applied, it must be so stated. Riveted yoke or key attachment.
Wheels and axles, R and R	Cast steel, cast iron, wrought steel or steel tired wheels. New or second hand. Cause of removal (See MCB rule 10). MCB or non-MCB, length of axle, diameter and length of journal, diameter of wheel fit, diameter of center of axle. (Only one dimension for length of journal, diameter of journal or diameter of wheel fit to be given, which shall be the dimension nearest the condemning limit.) All markings on wheels and axles; if no marks are found, a notation to that effect must be made.
Journal Bearings	Box number (See MCB rule 14). New or second hand (relined journal bearings are considered as new). Solid filled or other kind R & R. Make or name. Length of journal. Box number (See MCB rule 14).
Brake shoes, applied	New or second hand. Cast or reinforced back.
Metal brake beams, R & R	New or second-hand applied, if MCB, and number of same, or non-MCB. Make or name. Cause of removal.
Triple valve, R & R	Make and type. When cleaned, must show "tested, per Rule 60" (when so tested), to justify charge.
Air hose applied	New or second-hand.
General	Finished sizes of lumber. Feet of lumber. Value of miscellaneous items. Hours of labor. (The above information to be shown opposite each item, except where no bill is rendered.)

When lead paint is used, it must be so specified.

When triple valve, cylinder or centrifugal dirt collector is cleaned, the initial of road and date of last previous cleaning must be shown.

If necessary to remove the load to make repairs, as specified, it must be plainly stated.

When tank or safety valve of tank cars are tested in accordance with the MCB specifications for tank cars, the certificate of test as required by the Interstate Commerce Commission regulations must accompany the billing repair card.

Interpretations Regarding Billing

Q.—Is it necessary to show the dimension for over-all length of axle, in addition to showing whether MCB or non-MCB length?

A.—No, the over-all dimension need not be shown.

Q.—Is it necessary to show how much of the flange, tread, rim, etc., is defective on wheels removed? Is the term "worn flange" or "chipped flange" sufficient without showing how thick the flange is when removed or how long the chip is?

A.—For cast iron or cast steel wheels it is unnecessary to show any dimensions or qualify the terms in any way, as it is assumed that the repairing line would not remove the wheels unless the defects were beyond the limit of safety. In so far as wrought steel wheels are concerned, it is necessary to furnish the information specified. In noting the cause of removal of wheels and axle, standard terms shall be used. In all cases of wrought steel wheels, the actual thickness of tread must be shown before and after turning off, measured from the base line of the tread to the condemning limit of the tread, which is ¼ in. above the witness groove; also show the actual thickness of tread on other wheels ap-

plied. This information must be reported to car owners regardless of whether or not repairs are chargeable to the owners.

Journal bearings having a babbitt lining ⅜ in. thick or thicker shall be charged as filled journal bearings, and not as solid journal bearings.

The evidence of a joint inspector, or the joint evidence of two inspectors, one representing the owner of the car and the other representing a railroad company, subscriber to the MCB rules, that the repairs are not proper, shall be final; the evidence to be signed only after an actual inspection has been made.

A joint evidence card should be used for this purpose, which shall describe and show the location of parts repaired or renewed. This card shall be of the form prescribed. If repairs are not corrected at the time of inspection, the joint evidence card shall be attached to the car. Joint evidence must be obtained within ninety days after first receipt of car home. The joint evidence may be obtained at any point on the home line at which the improper repairs are found, but preferably at the point where the car is received, and only after an actual inspection is made.

The joint evidence card showing copy of billing repair card covering wrong repairs, when wrong repairs have been corrected, shall be sent to the company issuing such billing repair card. If within 60 days from the date of such request the latter does not issue its MCB defect card covering, bill made on copy of joint evidence and copy of billing repair card shall be final authority, provided the wrong repairs mentioned on joint evidence card are covered by such billing repair card. It must be stated on back of joint evidence card where and when the wrong repairs were corrected.

The end of car toward which the cylinder push rod travels shall be known as the *B* end and the opposite end shall be known as the *A* end.

Facing the *B* end of the car, in their order on the right side of the car, wheels, journal boxes and contained parts, shall be known is *R-1*, *R-2*, *R-*c, *and R-3*, and similarly those on the left side of car shall be known as *L-1*, *L-2*, *L-3* and *L-4*.

Defect cards and joint evidence cards must be securely attached to the car with at least four tacks, preferably on the outside face of an intermediate sill between cross-tie timbers on wooden cars, and on steel cars to a cardboard located either on a cross tie under the car or on the inside of the sill at the end of the car.

Duplicate defect, billing repair or joint evidence cards must be furnished promptly, on request, for lost or illegible cards.

Any car having defects which render it unsafe to run, unsafe to trainmen, or to any lading suitable to the car, may be repaired.

Repairs to foreign cars shall be promptly made, and the work shall conform in detail to the original construction, and with the quality of material originally used.

Standards for Repairing Foreign Cars

In repairing foreign cars:

(a) Defective non-MCB standards may be replaced with MCB standards (which must comply with MCB specifications), provided such substitution does not impair the strength of the car. Any increased cost resulting from and any expense of alteration necessary for the application of such MCB standards shall be charged to the car owner. Scrap credits are to be allowed for undamaged parts thus removed.

(b) Malleable iron, wrought iron or steel MCB standards may be substituted for each other or for gray iron MCB standards, gray iron MCB standards applied in lieu of malleable iron, wrought iron or steel MCB standards shall be considered as wrong repairs.

(c) In replacing MCB standard couplers, MCB type D Couplers or MCB temporary standard couplers, the dimensions of shank and butt of MCB couplers standard to the car must be maintained, except that 9-½ in. butt may be substituted for 6-½ in. butt when used with MCB standard yoke in substitution for non-MCB standard yoke.

(d) If the car owner elects, on account of improper repairs, to remove an MCB standard coupler, MCB type D coupler or MCB temporary standard coupler in good condition, second hand credit should be allowed, and charge be confined to second hand coupler applied.

(e) MCB No. 2 brake beams may be used in repairs to all freight equipment cars equipped with MCB No. 2, MCB No. 1 or non-MCB brake beams. Any increased cost resulting from the application of No. 2 brake beams to be borne by the car owner. MCB No. 3 brake beams must be replaced in kind.

(f) The billing repair card must specify the kind of material applied and removed, and the bill rendered in accordance therewith.

(g) Cast-iron brake shoes may be replaced with brake shoes having a reinforced back and the increased cost charged to the party responsible for the repairs.

(h) White pine, yellow pine, fir or cypress may be used when repairing siding, when of equal grade or quality to the material standard to the car. Fir, oak or southern pine may be substituted for each other in the renewing or splicing of longitudinal sills and side plates. Oak and southern pine may be substituted for each other in renewing end plates. Fir and southern pine may be substituted for each other in renewing or splicing end plank and side plank.

(i) Brake shafts, sill steps, uncoupling levers and grab irons must not be welded.

Cotter keys are not to be applied to knuckle pins of couplers on cars other than hopper and fixed-end gondolas.

Interpretations—Q.—Does the substitution of a New York auxiliary reservoir and cylinder in place of a Westinghouse constitute wrong repairs?

A.—The substitution is permissible, inasmuch as these details are interchangeable and are of the same dimensions, and the substitution of one for the other is not wrong repairs.

Q.—We are having trouble in living up to the Interstate Commerce Commission rules regarding end ladder clearance, due to the fact that some railroads do not replace our couplers with those of the latest dimensions, namely, 9-¼ in. from inside face of knuckle to striking face of coupler horn. What protection is offered under the rules?

A.—That end ladder clearance may be maintained, couplers of less than 9-¼ in. from inside face of knuckle to striking face of coupler horn should not be applied in repairing foreign cars. This should not be construed to mean that a coupler with 9-¼ in. dimensions may be submitted for the MCB temporary standard coupler or the MCB standard Type D coupler.

Q.—Will it be necessary to stencil cars equipped with the D type of coupler in order to protect them against substitution of the present type of coupler?

A.—Yes.

Q.—Is it permissible to charge for cast steel bottom brake rods applied to foreign cars when wrought iron is standard to the car?

A.—Inasmuch as the association has a standard bottom connection, it is permissible to make use of cast steel in this connection. The charge should be on the basis of material applied and the credit on the basis of material removed.

Q.—Is it permissible to charge for cast stel wehen cast steel column castings are applied in place of malleable iron standard to the car?

A.—Cast steel may be substituted for malleable iron but the charge should be limited to the kind of material removed. The association has no standard column casting.

Q.—Is it proper in cases where a K-2 triple valve has been applied in place of a G.N.-2 triple valve to scrap the G.N.-2 valve, or should the charge be confined to a charge for cleaning?

A.—If the car was built prior to Jan. 1st, 1915, no charge for this betterment could be made, except upon authority of the car owner.

Q.—In connection with the interpretation of the 1916 code of rules regarding the substitution of Westinghouse triple valves for New York triple valves, or vice versa, what triple vales manufactured by the Westinghouse and New York air brake companies are considered as being of similar types?

A.—The MCB standard K-1 and K-2 triple valves, manufactured by both the Westinghouse and New York air brake companies are the only triple valves that can be properly considered of similar type.

Improper Repairs

Any company making improper repairs by using material which the repairing line should carry in stock is solely responsible to the owners. Such improper repairs must be corrected within nine months after first receipt of the car on the home line, to justify bill.

The company making such improper repairs must place upon the car, at the time and place the work is done, an MCB defect card, which card must state the wrong repairs made.

In order that repairs to cars may be expedited as fully as possible, foreign or private line cars may be repaired by the handling line by using material from their own stock instead of ordering material from the car owner, in which event the repairing line is absolved from all responsibility for the cost of standardizing repairs thus made.

Interpreation: Q.—In the event of using wrong material from stock, instead of ordering correct material from the car owner, are such repairs chargeable to the owner?

A.—Yes, provided the original defects are owners' responsibility.

Companies shall promptly furnish to each other, upon requisition, and forward, freight or express charges collect from point of shipment, material for repairs of their cars on foreign line. If the material is for repairs of car owner's defects, the foreign company may bill the car owner for the entire freight charges, and in such case the car owner may reclaim freight charges for the portion of the movement over its own line. If the material is for repairs of user's defects, the foreign line may reclaim only for that portion or the movement over its line. A separate bill, with copy of freight, express or due bill attached, should be rendered for the freight or express charges, showing reference to the bill covering repairs.

Requisitions for such material shall specify that it is for repairs of cars, giving the number and initial of such car, together with pattern number, sketch or other data to enable correct filling of the requisition. Material weighing less than 50 lb. gross weight ordered from the car owner must be shipped by express.

The company having the car in its possession at the time shall provide from its own stock the following: Lumber, forgings, hardware stock, paint, hairfelt, piping, air brake material and all MCB standard material.

Interpretations: (1) Q.—If material is shipped by local freight to repair owner's defects, who should pay the cartage from the freight depot to the repair tracks?

A.—There should be no charge for cartage.

Q.—(2) What items are covered by the word "forging"?

A.—Commercial shapes, such as channels, Z-bars, etc., should be furnished by the repairing line. Pressed steel shapes which require special dies for their forming should not be carried as forgings; such material should be furnished by the car owner.

On May 14, 1919, the American Railroad Association Section III—Mechanical—issued circular No. S-111-37, making certain changes in the rules of interchange. The changes again make car owners responsible for and therefore chargeable with, the following items of repairs, which prior to April 15, 1919 were not to be billed for.

1. Air hose gaskets, applied, except with hose complete, applied.
2. Bolts, 6 in. long or under, applied, except when used to complete items of repairs not herein listed.
3. Brake beam finger guard pins, finger guard pin castings, safety chain clips, safety chains, links or hook bolts, applied.
4. Brake hangers, repaired or applied, except with renewal or change of brake beam.
5. Brake hanger pins or bolts, applied.
6. Brake pawl, applied.
7. Brake pins or key bolts, applied.
8. Brake ratchet wheel keys, applied.
9. Brake shaft rings, applied.
10. Brake shoes, applied.
11. Brake shoe keys, applied.
12. Carrier iron, Bettendorf type, when turned over, no charge for adjustment.
13. Coupler release clevises, clevis rings or chains, clevis pins or bolts, applied.
14. Door hasps and staples, applied, except with complete door, applied.
15. Door seal pins or chains, applied, except with complete door, applied.
16. Journal box lids and bolts, or springs for same, applied.
17. Knuckle locks, applied, except with coupler, complete, applied.
18. Knuckle lock sets, applied, except with coupler complete, applied.
19. Knuckle pins, applied, except with coupler complete, applied.
20. Lag screws, applied, except when used to complete other items of repairs not herein listed
21. Nuts or lag screws tightened.
22. Nuts, applied, except those used in renewing bolts, other than bolts 6 in. long or under, where the latter are used in completing items of repairs not herein listed.
23. Nut locks, or lock nuts, applied.
24. Pipe fittings, union gaskets, pipe hangers, clamps, and cutting of pipe threads, except with renewal of any or all air brake on retaining valve pipe.
25. Refrigerator car door hooks, applied.
26. Rehanging side or end doors.
27. Release lever brackets, applied.
28. Release valve rods, repaired or applied.
29. Renailing sheathing, lining, facia or roofing.
30. Spring cotters and split keys, applied.
31. Straightening brake shafts and uncoupling levers when not removed from car.
32. Staples, applied.
33. Wood screws, applied, except when used in renewal of running board.
34. Washers, applied.

The circular also provides that defect cards shall be required as between all roads for cars having defects for which the delivering line is held responsible under MCB rules.

Defect cards shall also be required as between all roads for improper repairs made to cars as per MCB rules 12 and 13.

Delivering lines again become responsible to the receiving line for the cost of transferring or adjusting lading on cars as per MCB rule 2 and A.R.A. rule 15.

This circular also abrogated modifications *A*, *B* and *C* of the Interchange Rules governing passenger train cars, so that defect cards are again required for delivering line defects on cars offered in interchange, also wrong repairs made to foreign cars. Gas certificates must be issued to the delivering line to cover gas in holders of cars received and when passenger cars leave the road a gas certificate must be requested from the road receiving the car.

Interchange at Chicago

At Chicago, the handling of cars in interchange will be in accordance with the Chicago Car Interchange Bureau's instructions, a copy of which follows:

In accordance with American Railroad Association, Section III Mechanical Circular No. S-111-37 dated May 14th, 1919, effective June 1st, 1919, the cost of transferring the lading of freight cars or re-arrangement of lading at junction points in the Chicago Switching District, including the main line of the EJ&E from Waukegan, Ill. to Porter, Ind. shall be handled as follows:

First: The delivering line shall pay cost of transfer or rearrangement:

(a) When transfer is due to defective equipment that is not

safe to run according to MCB rules, *except where the repairs can be made under load as per MCB rule 2.*

(b) When transfer or arrangement of load is due to contents being improperly loaded or overloaded, according to MCB rules, or the Interstate Commerce Commission regulations for the Transportation of Explosives and other dangerous articles by freight and by express, or when dimensions of the lading of open cars are in excess of the published clearances of any of the roads covered by the routing.

(c) When transfer is due to the delivering line not desiring its equipment to go beyond junction points.

(d) When cars cannot pass the approved clearances of the American Railroad Association.

SECOND: The receiving road shall pay the cost of transfer or re-arrangement:

(e) When cars cannot pass clearances, except as provided in paragraph (d), or when cars and lading exceed load limit or cannot be moved through on account of any other disability of the receiving line.

(f) When receiving road desires transfer to save cost of mileage or per diem.

THIRD: Transfer orders shall not be issued against belt or intermediate switching lines, except:

(g) For defective or improperly loaded cars when load originates on their rails.

(h) For defects which develop after receipt from trunk lines, providing defects existing on receipt of car were not the cause of subsequent damage which necessitated transfer of car, or readjustment of lading.

(i) Cars delivered to belt or intermediate switching line with defects which would make transfer necessary either by the belt or intermediate switching line or their connection, if transferred by the latter, the belt or intermediate switching line is to be relieved of the cost of transfer, and transfer order issued against the trunk line delivering the car to the belt or intermediate switching line.

FOURTH: Seven dollars per load will be charged for such transfer or re-arrangement, except in cases of adjustment of lading and application of door protection in house cars, a charge of two dollars will be made.

FIFTH: *All* roads in the Chicago switching district, in so far as the transfer of loaded cars or the adjustment of lading is concerned, shall arrange as follows:

(1) Car foremen, inspectors and others will be required to fill in all information on form 159-A and must also show on same what disposition was made of the car after it has been transferred, showing to what shop the car was carded for repairs after transfer, or if it is a Chicago owned car it must be shown that the car was carded home to the car owners for repairs. In cases where cars are transferred for old defects, or the lading is readjusted due to the car being originally improperly loaded, the form should be made out in quadruplicate and in cases where the cars are transferred or lading readjusted due to new damage or the lading is adjusted due to rough handling, it should be made out in duplicate and forwarded to the chief interchange inspector, who will issue authority for transfer or adjustment of lading against the road responsible.

(2) No authorities for transfer will be furnished for cars having the following defects:

(a) Defective wheels and axles under all cars.

(b) All other truck defects on home cars.

(c) All other truck defects on foreign cars, except metal bolsters, center plates, where cast integral with bolsters, metal truck sides, metal truck transoms and metal spring planks, also excepting non-MCB standard journal boxes and contained parts in cases where the MCB standard is not a proper substitute.

(d) Defective outside wooden end sills on all cars.

(e) Defective body center plate and center plate bolts that do not pass through center sills on all cars, except when such center plates are cast integral with bolsters on foreign cars; also center pins that are not applied from inside of car on all cars.

(f) Renewal of roof boards of outside wooden roofs, and of inside metal roofs, where such renewal does not exceed 25 per cent of the roof boards, and where purlines, rafters, ridge pole, side and end plates are in good condition, on all cars.

(g) Missing or defective side doors (except that an adjustment order may be obtained to apply proper door protection, as required by the Loading Rules), end doors, roo doors and hatch covers on all cars.

SIXTH: The repairs to car or transfer of lading is to be done by the railroad having facilities nearest available. If facilities are equally available by both railroads, the car will be moved to facilities located in the direction car is moving.

SEVENTH: Bad order cars which previously had been delivered in bad order under load must be repaired by the road making transfer if they have facilities and material; if not, the nearest repair point on any line, having material and facilities should make repairs—with the exception of Chicago owned cars, which may be delivered to the car owners for repairs.

At Minneapolis and St. Paul the handling of cars in interchange will be in accordance with the Twin City Joint Inspection Association Bulletin which is similar to the Chicago regulations.

At Minneapolis and St. Paul the handling of cars in interchange will be in accordance with the Twin City Joint Inspection Association Bulletin which is similar to the Chicago regulations. At Council Bluffs and Omaha the handling of cars in interchange will be in accordance with an agreement which is practically the same as the Chicago agreement. At Kansas City the interchange of cars will be handled in accordance with an agreement which will also be practically the same as the Chicago agreement. At other interchange points the interchange of cars will be handled strictly in accordance with the MCB rules, unless there be some local agreement to the contrary.

FREIGHT CAR ROOF CONSTRUCTION*

BY H. R. NAYLOR

It is interesting to note the progress made on this continent in car roof construction from the time when the outer covering consisted only of a single layer of boards having tongue and grooved joints. In many instances, I believe it was customary to use a wood shingle roof similar to that commonly used in house construction. Another method adopted, presumably to overcome the leakage, was to apply the roof boards lengthwise of the car, overlapping each other similar to clapboarding on present-day wooden buildings. This method of construction proved unsatisfactory, and gave way to the double board roof which can be seen on a large number of cars even today. This was a decided improvement over the earlier types of roof, especially when at a later date a layer of waterproof paper was applied between the first and second course of boards, which became known as the "plastic roof." This roof undoubtedly protected the lading for some time, but it eventually became waterlogged, and a method was then sought to prevent the water leaking between the joints of the top course of boards which rapidly destroyed the paper and bottom boards. This was overcome to a great extent by grooving the face of the top boards, the grooves acting as drains, carrying off the water, and protecting the joints from possible leakage. In fact, this is the most common type of roof to be found on stock and refrigerator cars at the present time.

The Sub-Metal Roof

The next step was a distinctly new departure, and brought into existence the metal sub-roof, over which a wood roof was applied for protection only. The roof framing consisted of a ridgepole, carlines and purlins, to which an addition was made in the form of cross rafters. The galvanized metal sheets were formed with corrugations, and fitted into suitable grooves in the ridgepole and rafters, providing altogether a fairly effective watershed. But it was not long before the usual complaints were being made about this new metal roof, owing to the grooved edges of the wooden rafters breaking away, allowing the metal sheets to sag and leak. This defect was eventually overcome by flanging the roof sheets, and applying a metal capping over the rafters, which enclosed the flanges of the roof sheets, making a continuous metal water-

*From a paper presented at the Canadian Railway Club by Mr. Naylor, who is assistant works manager, car department, Canadian Pacific Railway.

shed for the full length of the car. With a few later modifications this was the final attempt along the lines of a metal sub-roof.

Some of the principal objections to the metal sub-roof are that the roof sheets in time buckle up at the eaves, and work out of the grooves in the ridgepole. With the constant twisting and straining of the car superstructure, the metal sheets and caps are soon displaced and bent, and in making repairs to the outer wood roof the metal sheets are frequently punctured by nails carelessly driven, all of which result in damage to the lading. The outer wood roof also requires frequent renewal, on account of constant exposure, which is a rather expensive item when added to the cost of maintaining the metal sub-roof.

The demand for improved roof construction was then met by adopting a roof framing made of steel, as in other parts of the car; for instance, the wooden carlines which were bolted to the sideplates, and a source of constant trouble, gave way to the steel carlines of various shapes, riveted to the sideplates, in order to give greater rigidity and strength. Other parts of the roof framing were improved and reinforced in a similar manner, providing greater stability, which is most essential if the outer roof is to be protected from the racking and straining of the car superstructure.

Outside Metal Roofs

The demand for greater stability was largely responsible for an entirely new departure in roof design, for instead of placing the wood roofboards on the outside, as in the case of the metal sub-roof, the plan was reversed, the roof boards being applied direct to the roof framing, and the metal roof sheets used as an outer protection for the boards in addition to acting as a watershed. The roof boards in this case being applied direct to the roof framing had the effect of bracing the roof against cornering and bulging, and brought into extensive use the outside metal roof.

The outside metal roof usually consists of one course of 13/16-inch tongued and grooved boards, securely fastened to the roof framing, the outer metal roof being formed of galvanized iron sheets generally of No. 22 gage. At the junctions of the main sheets suitable weather-proof protection is provided by metal caps, formed in various ways to interlock with the flanged edges of the main sheets. The method of securing the outside metal sheets at the eaves is very different to that on the metal sub-roof. The roof sheets on the latter type are prevented from lifting by the capping and outer wood roof, the fascia boards securing the sheets laterally on the car, making nailing unnecessary at the eaves. On the outside metal roof the main roof sheets or eave flashings are flanged at the eaves and secured to the outside of the fascia boards. This difference in the method of attachment on the early types of outside metal roofs, which were not designed to allow freedom of movement at the roof sheet intersections, resulted in cracked sheets and a considerable number of defective roofs, but eventually this was entirely overcome by providing ample sideplay at the main sheet capping, and applying eave flashings, giving the roof the necessary flexibility to withstand the cornering, weaving and bulging of the superstructure.

Advent of the All-Steel Roof

We find roofs today built entirely of steel. In comparison with the composite roofs already described, the all-steel roof presents an entirely new departure in design, both in regard to framing and roofing. The roof sheets are usually of 1/16-inch galvanized steel, but in some instances the sheets are 3/32-inch thick and span the full width of the car, providing in themselves the necessary protection against puncture or other hard usage. Additional reinforcement can be obtained by corrugating the roof sheets at suitable intervals. The carlines in most cases are designed to provide ready means of connecting the roof sheets, in addition to supporting the roof, and bracing the superstructure of the car.

With the adoption of the all-steel roof, the question of flexibility becomes a very live subject. Some types provide for free movement of the roof sheets, in a similar manner to the flexible outside metal roof, while in others the roof sheets are flanged, capped and riveted together, forming in themselves an absolutely rigid roof. It is claimed for the first type that the roof should be sufficiently flexible to take care of the constant straining of the car body, while in the rigid type the roof is made strong enough to resist the straining of the body, and act as bracing for the superstructure.

The all-steel roof lends itself readily to the use of outside carlines, this arrangement giving the car a considerable advantage in loading space; other advantages being the reduction in fire risk, and final cost, owing to the life of the roof more nearly corresponding with other parts of the car and finally a greater safeguard against leakage is obtained by the use of thicker sheets, which resist corrosion and cracking to a greater extent, and as a result this type of roof is gradually meeting with more general approval.

An objection which is sometimes raised against the all-steel roof is the claim that under certain conditions it is liable to sweat, resulting possibly in damage to lading. For instance, freshly milled flour containing a high percentage of moisture, and which is usually hot when loaded, quickly raises the temperature of the car above that of the outside atmosphere. It is claimed that the metal roof being then subject to two widely varying temperatures commences to sweat, and that the resultant moisture is sufficient to damage the contents. It is questionable, however, if this is of enough importance to warrant special attention when building box cars for general service requirements, but as a measure of precaution effective steps are being taken to prevent the possibility of this occurring even under the most extreme conditions, and eventually there is good reason to believe that the all-steel roof will meet all requirements.

Conclusions

As previously mentioned, the double board roof is the most common type on refrigerator and stock cars today, and while it meets the requirements for stock cars, it is rather surprising that a better roof has not been previously adopted for refrigerator cars in order to protect more effectively the insulation. In making repairs to this class of car it is often necessary to renew the whole roof insulation, and ceiling, which have become waterlogged and decayed, owing to the poor protection offered by the double board roof. The entire side and end framing, with their insulation, are often affected in a similar manner, due to the water working down through the defective roof. These conditions are becoming better recognized, and as a result we find the outside metal roof now being adopted for refrigerator cars. Owing to the metal roof being a greater conductor of heat it might be necessary to increase the roof insulation, but the added cost would be more than offset by the saving in maintenance.

A car roof should be so constructed that repairs can be made quickly and at a minimum cost. The position of the roof in relation to other parts of the car does not lend itself to proper maintenance. Trucks, air-brakes and draft gear are constantly being inspected for indications of possible failure, but unfortunately, and all too often, the only warning received of roof failure is when the damage has actually occurred to the lading. Car roofs should, therefore, be as far as possible self maintaining. Corrosion is an important factor in modern roof maintenance and calls for a systematic method of painting, for it cannot be expected that the galvanizing will protect the roof sheets indefinitely. The best designed car roof will only last in proportion to the maintenance it receives, and the object should be to make the life of the roof equal to the life of the car.

Discussion

L. Brown:—Each year the average car goes on the repair track five times during the year. When a car is built the roofs are generally in good condition and very few are found leaking. The trouble is not in the new roofs but in the old roofs that have been inservice for some time, very few of which do not leak. In looking over the defects in these cars we see that the boards are split, nails get loose and rust away and allow the water to get in through the nail-holes; metal sheets when unsecured, get loose, distorted and punctured. Caps over the inside metal roofs frequently become loose and the water follows the nail holes to the inside of the car. Nails securing the parts on the outside metal sheets work up out of the side plates and through metal sheets; parts securing the outside metal sheets frequently allow the water to get around the sheets, which wear away by friction and become cracked over the side plates.

The all-steel roof has less objectionable features than the other types and the condensation of moisture has been overrated in proportion to its importance, and the shipments which are damaged by moisture are few compared with the damage caused by water leaking in from the outside. The condensation inside may be eliminated by proper ventilation or by the use of non-conductive materials on the inside.

Objection has been raised to the rigid roof on account of causing derailments, but there is little justification for that theory. I have made tests of various roofs on empty cars and loaded cars with various types of roofs, and find that the additional force necessary to twist the cars having rigid roofs is negligible. The rigid roofs are not blamed for derailments of passenger cars which have such roofs and travel faster, have greater side bearing movement and have permanently heavier loads.

E. V. Harrison:—From an operating standpoint it is not so much the damage to merchandise from the roofs as from the side sheeting. During the past few years in the case of new cars turned out we have not had any side sheeting, with the result that considerable damage has occurred not only to flour but to other merchandise as well. I do not want to give any secrets away to the industrial people, but this is a thing which we have had to contend with both in regard to claims and damage.

James Coleman:—There are more loss and damage claims as a result of leaky car roofs than from any other direct cause, and I think the time is coming when the all-steel car roof will be adopted universally for the reason that it prolongs the life of the car, and if well constructed and properly applied will last almost the life of the car. The question has been raised as to the sweating of the steel roof in cars loaded with flour, but I think investigation will show that responsibility for this rests principally with the people who load the flour and fail to take precautions to prevent claims for damage. In October, 1919, a circular was issued by the U. S. R. A. to fifteen railroads at St. Paul and Minneapolis, where an embargo had been issued against the loading of flour in cars with all-steel roofs.

(*Paragraph from U. S. R. A. Circular*).—Upon further investigation it has developed that where flour is loaded in a warm condition in any kind of a car, whether *all steel or all wood roof*, if the temperature of the weather is very low, there will be condensation of moisture, due to the fact that there is no ventilation in the car and consequently it will cause this sweating.

The Western Weighing and Inspection Bureau has issued instructions on this subject, which read as follows: "In the interest of claim prevention, we should endeavor to prevail upon the flour mill people not to load their flour in a warm condition into cars during extremely cold weather; but, if they do so load it, then the flour should be covered with paper in order to protect same against the drippings from the sides or roofs of the cars."

Some all-steel roofs are constructed with a means provided for ventilation at the eaves, and with this means any moisture deposited on the underside of the roof sheets will be evaporated by this circulation. This possibly would not provide circulation enough with hot flour in the car, from 60 to 80 degrees, but this means of circulation will provide for any moisture that may be deposited on the roof sheets under ordinary lading. In confirmation of this, I have never yet heard of a report of sweating of room except of reports made by the people of Minneapolis and St. Paul in loading flour.

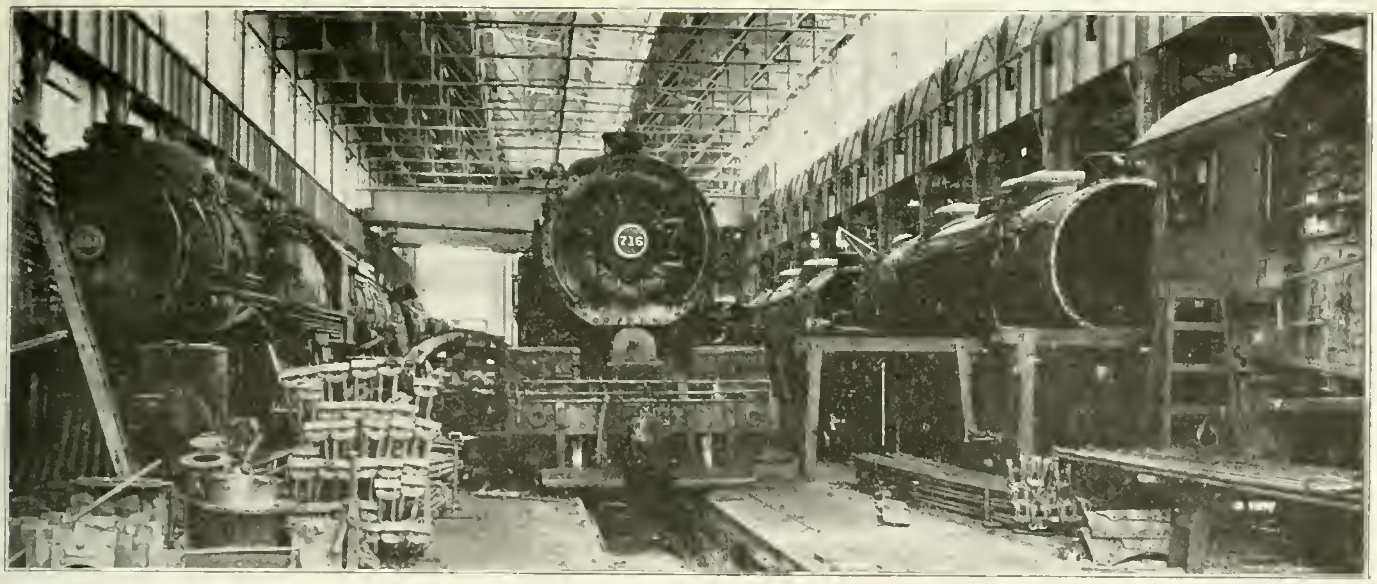
With the years of experience that these people have had at Minneapolis and St. Paul, they now admit that moisture will be deposited on a roof of any kind when the flour in the car is loaded at a high temperature, and they have given instructions that some covering—paper or tarpaulin—must be put over lading when loaded at a high temperature, in order to prevent the moisture dripping from the roof; either from a wooden or all-steel roof.

H. R. Naylor:—We are getting to the time when the modern car roof will take the form of an all-plate roof. For some time it has been more or less of a thin plate roof, but I think in the development of the all-steel roof, the tendency will be to use sheets of heavier gage, say ⅛-inch thick or heavier, thus making a good solid plate roof. When this is done the roof will more nearly last the life of the car, whereas today the average roof has to be renewed two or three times in the same period. By adopting a roof of this type, there should also be a tendency to avoid designs which are in any way complicated in order to reduce to the minimum the possibility of leakage, and enable them to be easily maintained. The roof, therefore, should be designed with the least possible number of sheet joints, the joints being formed and secured in such a manner as to make them absolutely weather proof. Providing the roof sheets are protected from the straining of the roof frame, there would appear to be no necessity of providing for flexibility. The superstructure should be well braced to protect the roof framing, and the roof framing should also be braced diagonally to protect the roof sheets from undue racking and strain. If we take care of the strains set up in the superstructure and transferred to the roof framing, then we should be able to use an all-steel roof of simple design, which need not necessarily be flexible.

W. J. Hyman:—A few years ago I examined a great many outside metal roofs that had been in service from four to six years, and on some of these roofs the paint was scaling off, on others along the edges of the carlines the weaving of the car had caused the paint to rub off and naturally they had started to rust. If some of our paint manufacturers could supply a paint which would stay on without scaling under extreme weather conditions and be elastic enough to take care of the weavings of the car it would go a long way in prolonging the life of the outside metal roof.

Norman Holland:—The question of being able to make a paint which will stay on roofs is extremely simple. You can make anything if the consumer will pay the price. It is possible to make a roof composition that will stay on cars. A sample I have consists of sixteen coats of such a paint and is made for passenger car roofs. It would be too expensive to make it standard for freight cars, although it might not be too expensive if you figured it out from the standpoint of maintenance cost. The point is that in dealing with freight car roofs you have to consider the joint in your board, and you cannot expect anything to be elastic enough to stand one half inch warping, and I have seen warps that were one and three-quarter inches.

Safety First.—Don't swing a sledge or hammer that you know is working loose on the handle, thinking it won't come off till "next time." You may not be hurt, but what about "the other fellow."

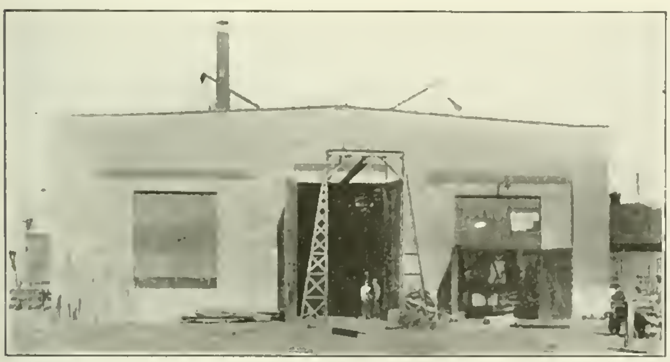


Interior of the Erecting Shop

EXTENSIVE ADDITIONS TO C. & O. SHOP

New Erecting, Machine and Blacksmith Shop and Brass Foundry Erected at Huntington, W. Va.

IN 1916 the Chesapeake & Ohio decided to enlarge the facilities for handling repairs to equipment at the main shops at Huntington, W. Va. The equipment owned by the road includes 923 locomotives, 395 passenger cars and 52,324 freight cars, and the increase in the amount of rolling stock as well as the increase in the size of the motive power necessitated an enlargement of the shops. Additional reasons for changes were found in the poor grouping of the existing buildings and the inadequate provision for lighting, heating and transporting material.



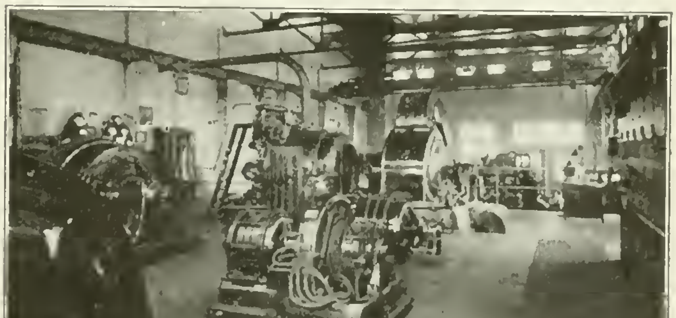
West End of the Blacksmith Shop

The site of the Huntington shop is a plot approximately 5,000 ft. by 850 ft., or about 100 acres, located north of the main line tracks. After a study of the requirements an expansion of the shop to three times the existing size was decided upon. Plans were laid for carrying out the changes without interfering with the operation of the shop and the improvements were divided into three stages. The first stage has now been completed, the second will probably be carried out in 1921 and the third without material delay.

First Stage of the Improvements

The work included in the first stage of the plan comprised the following steps: (1) the erection of a new brass foundry, increasing the floor area for this work from 8,500 sq. ft. to 14,000 sq. ft.; (2) the building of an addition to the blacksmith shop, increasing the area from 22,000 sq. ft. to 30,000 sq. ft.; (3) the removal of the machinery from the freight car blacksmith shop to the new addition to the locomotive blacksmith shop; (4) the erection of a new longitudinal erecting and machine shop at the north end of the existing machine, erecting and blacksmith shops; (5) the installation of a 10-ton traveling crane between the blacksmith and machine shops, extending from the new erecting and machine shop to the storehouse; (6) the enlargement of the transfer table pit and the installation of the new transfer table; (7) the rearrangement of the steam and gas piping and electric wiring.

The Arnold Company of Chicago was employed to assist in developing the plans and to handle the construction work of the first stage.

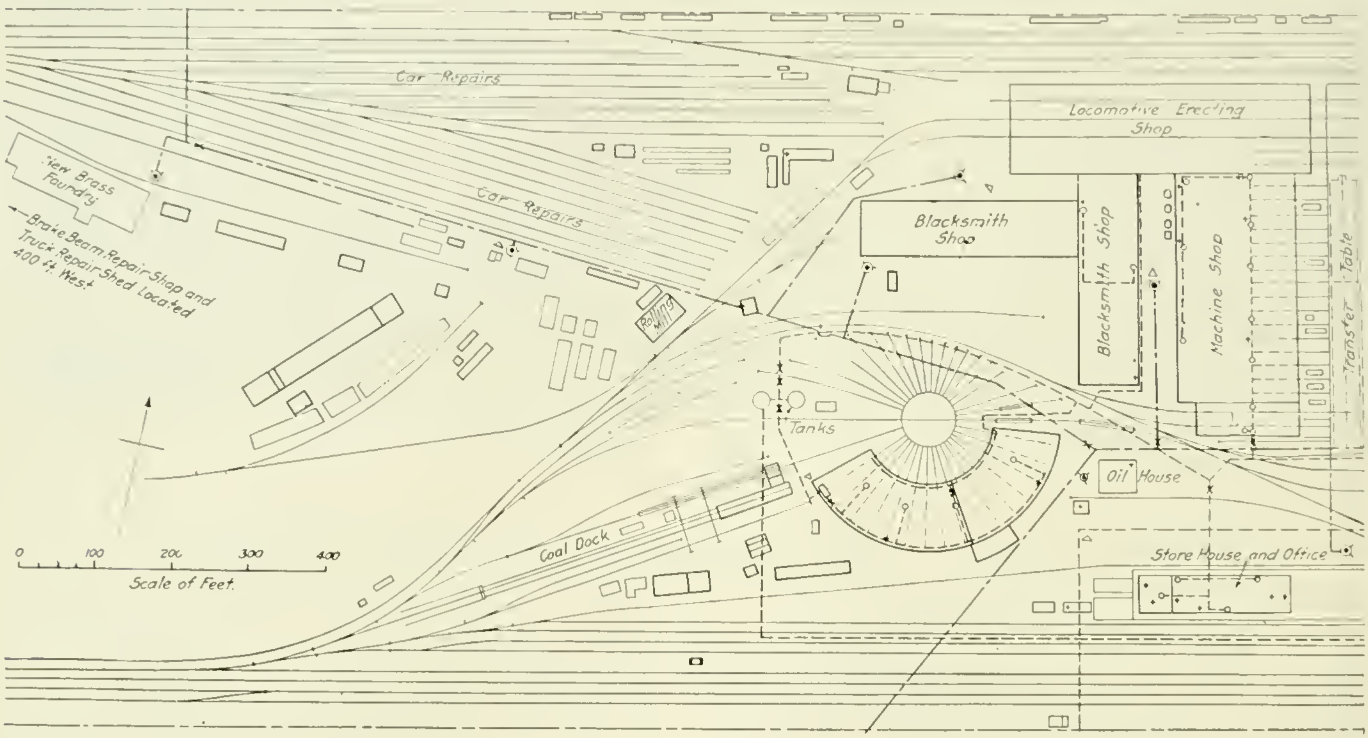


Interior of the Power House

Projected Improvements

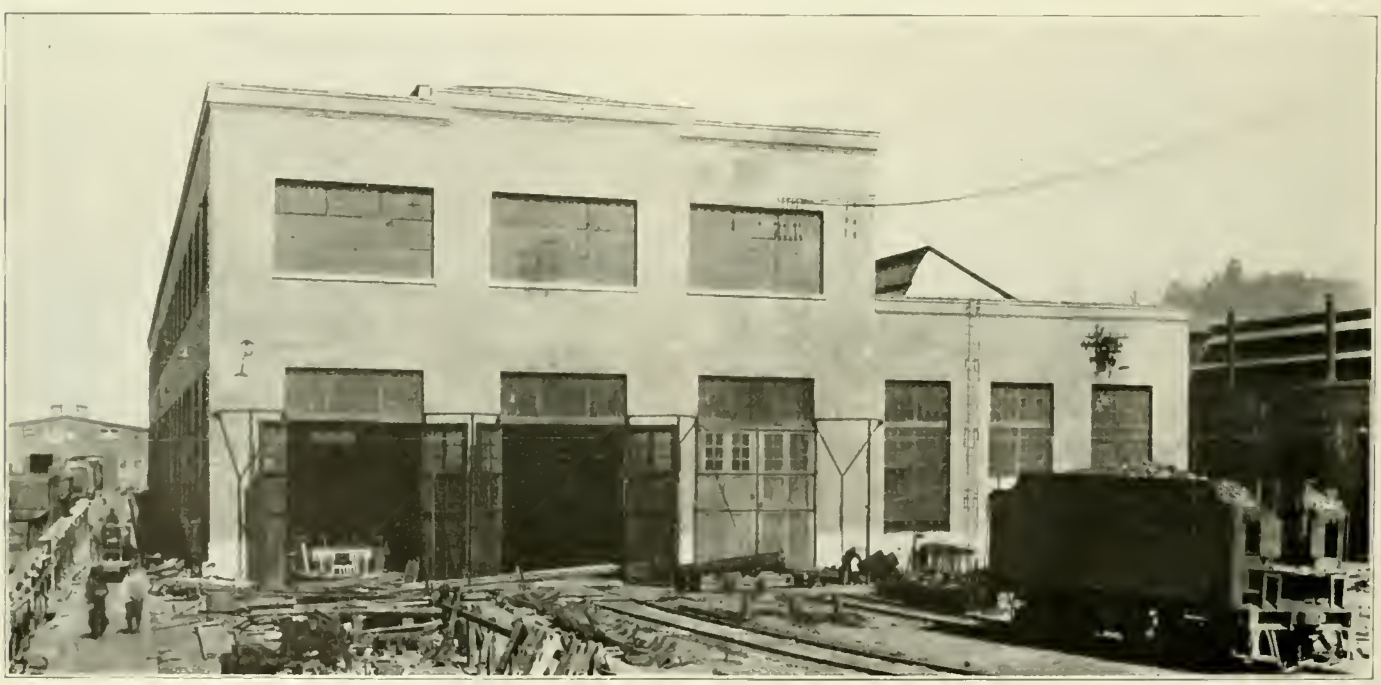
Second Stage.—The second stage consists of: (1) the removal of the present transverse erecting shop, which has been

in service for 40 years, and the construction of a new and modern transverse erecting shop equipped with overhead cranes; (2) alterations to the present machine shop in the way of improved lighting and additional sanitary and toilet facilities and general repairs on the building; (3) an exten-



General Arrangement of the Shops

sion on the office building to provide approximately 11,000 sq. ft. floor area; (4) the construction of a new reinforced concrete, fireproof oil and paint storage house including



West End of Erecting and Machine Shop, Blacksmith Shop at Extreme Right

storage tanks, pumps and modern oil house equipment; (5) an extension to the boiler plant to permit the installation of approximately 1,000 additional boiler h.p.; (6) the construction of a new lumber dry kiln and equipment; (7) an extension to the roundhouse; (8) the construction of paved roadways to displace a greater part of the present plank roadways within the shop grounds; (9) enlarging the boiler and tank shop.

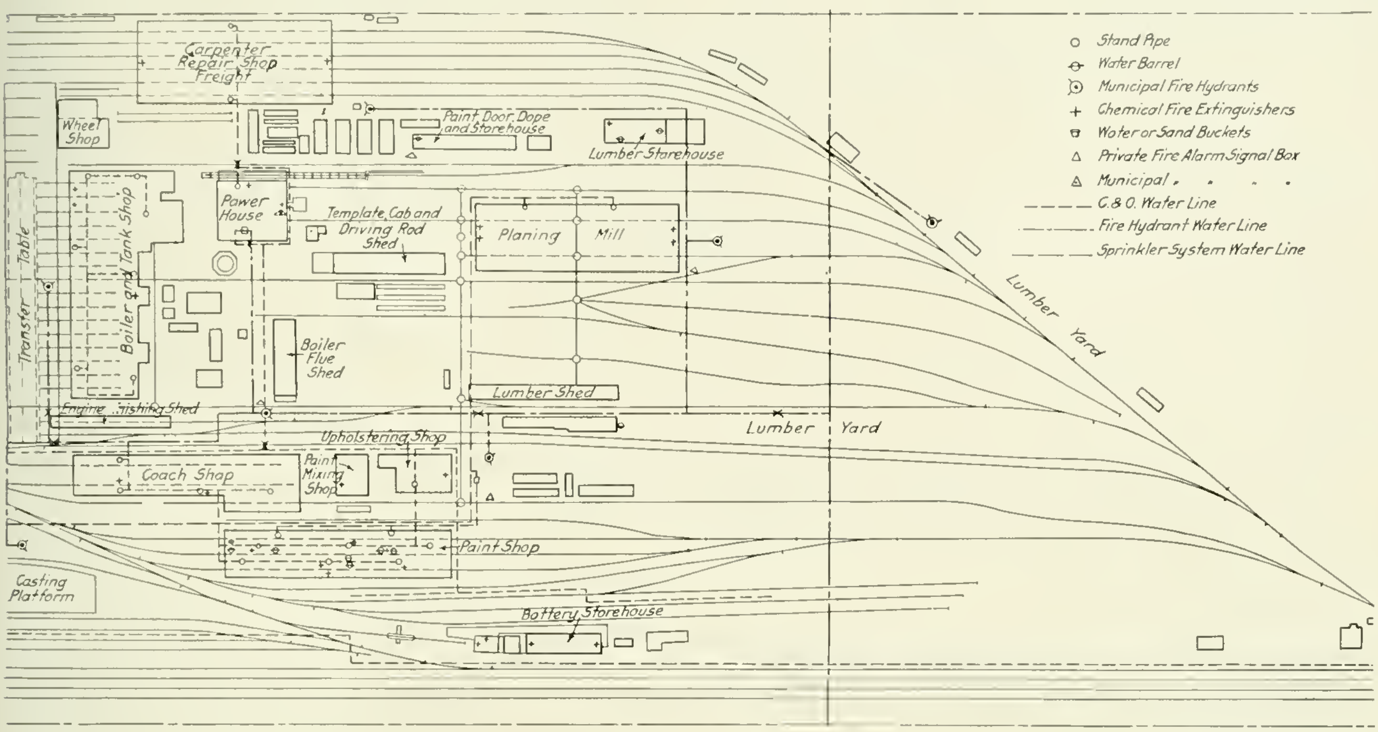
Third Stage.—The third stage consists of: (1) the filling of an area of low ground at the east end of the shop site and the construction of approximately 35,500 ft. of tracks for a new steel car repair shop and yard; (2) the construction of a new steel car repair shop approximately 1,200 ft. long, to shelter at least 68 steel coal cars undergoing repairs, this building to be equipped with modern traveling cranes; (3) the construction of a new freight car shop, blacksmith shop,

wheel shop and bolt shop complete with installation of equipment; (4) the construction of a new coach and paint shop and additional transfer table and pit serving this shop; (5) the construction of a new wood freight car repair shop for housing approximately 60 wooden freight cars undergoing repairs; (6) remodeling the present coach shop and converting it into a truck shop, tin and pipe shop, polishing and upholstery department.

With the completion of these new freight car repair facilities, the freight car work is to be removed from the present west end of the site available for a future extension to the locomotive repair shop and a large area available for a future reclamation plant and possibly an iron foundry. These three stages of the development, when completed, will be sufficient to take care of the needs for many years.

General Layout of the Shops

The facilities at Huntington shop include locomotive shops, car shops for both freight and passenger equipment, a brass foundry, a storehouse, an extensive reclamation plant and a complete engine terminal. As will be noted from the drawing of the shop layout, the tracks leading to the roundhouse leave the running tracks along the main line near the southwest corner of the shop grounds. These tracks also give access to the reclamation plant, to the west ends of the erecting and blacksmith shops and also to the south end of the



of the Chesapeake & Ohio, Huntington, W. Va.

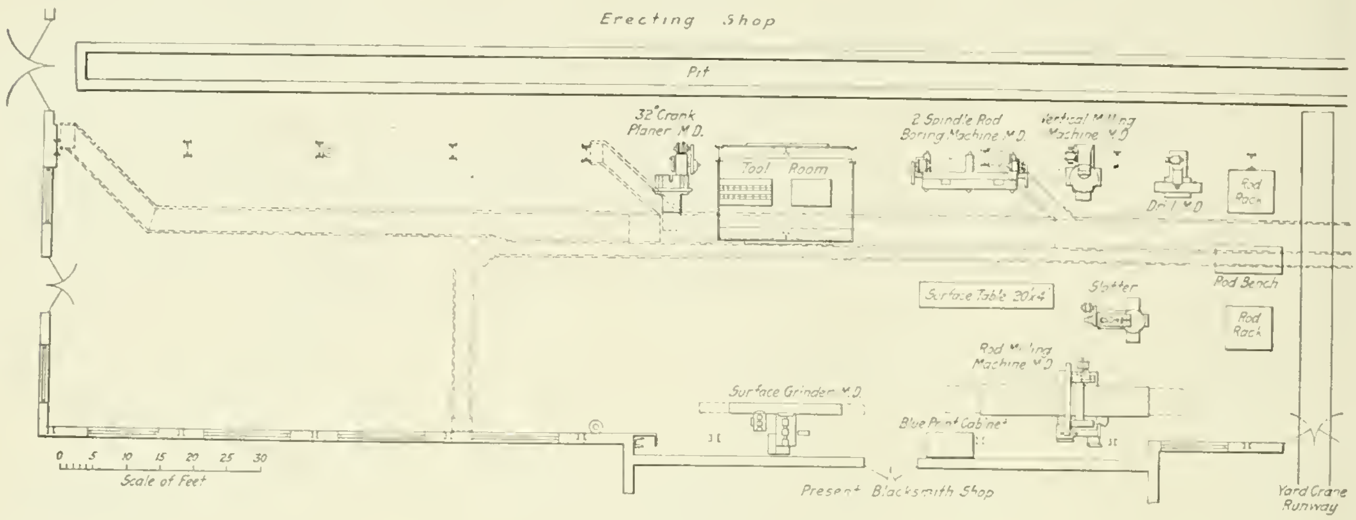
Heavy Machine Bay in the Erecting Shop

machine shop and the transfer table. The approach to the car repair shops and storehouse is from a lead at the east end of the shop. The locomotive shops can also be reached indirectly over these tracks. At the northwest section of the plot is a large car repair yard, served by two leads, and the brass foundry.

As the principal additions to the shops included in the first stage of the development, which was commenced in 1918 and completed in 1919, are all in connection with the locomotive facilities, the detailed description which follows is confined to that section of the plant.

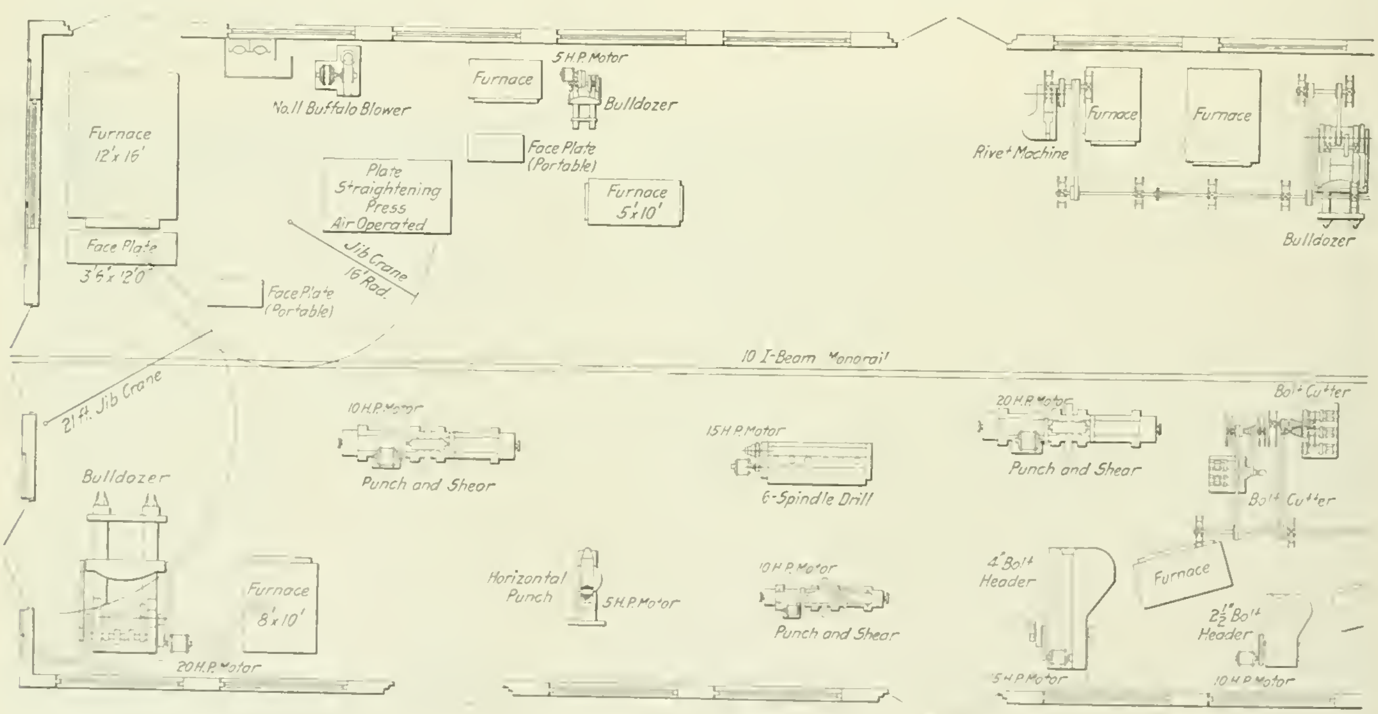
Erecting Shops

Locomotives undergoing repairs are placed on two sets of tracks, the Mallet and Mikado locomotives being shopped in the new longitudinal erecting shop, while the smaller power is set on transverse tracks in the machine shop building. The new erecting shop is 400 ft. long and 113 ft. wide. It is divided into an erecting bay 70 ft. wide and 41 ft. to the bottom of the roof truss, and a machine tool bay 43 ft. wide and 24 ft. to the truss. The building has concrete foundations and footings, concrete walls to the window sills, with brick side and end walls and pilasters. The framework and trusses of the superstructure are steel, over which is applied a wood roof covered with four-ply asphalt roofing. A ventilated steel sash is used in the side walls and monitors. The floor is of creosoted wood block over a concrete sub-base. Wooden doors of substantial construction are used. The erecting bay has two 150-ton cranes with auxiliary hoists of 10 tons and 5 tons capacity. The machine bay is served by one 10-ton crane.



Layout of Tools In

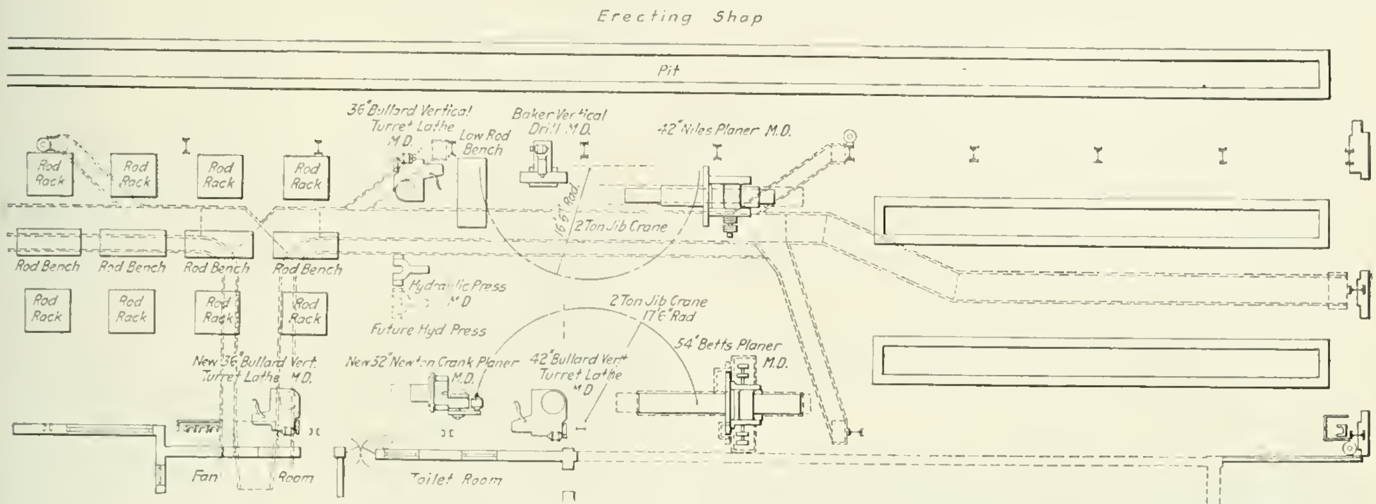
The machine shop and blacksmith shop extend south from the erecting shop and at right angles to it. The boiler and tank shop is in a separate building at the eastern side of the transfer table pit, which has been enlarged. The rebuilt transfer table was made by extending the old table along practically the same lines but of heavier construction, as shown in the drawing, with the addition of more powerful motor, gearing and shaft. A special type of drive for the table was designed by the mechanical department with a



Arrangement of Equipment

50 hp. 230 volt, D. C. crane motor geared to a drive shaft having shifting gears to mesh with the main drive of the table, or for driving the pulling drums, one of which is located at each end of the table for pulling engines on or off the transfer table.

Between the machine shop and blacksmith shop is a crane runway 50 ft. wide, which extends 520 ft. from the erecting shop, ending over the unloading platform at the storehouse. machine shop. The wheel department, which is located at the south end of the machine shop, is equipped with two axle lathes, a truck wheel boring machine, a boring mill for tires and wheel centers, a wheel press, and a 96-in. wheel lathe. Two wheel lathes of lighter construction are used for truing journals, for turning mounted wheel centers and similar work. On practically all locomotives on the Chesapeake & Ohio lateral wear is taken up by brass liners on the driv-

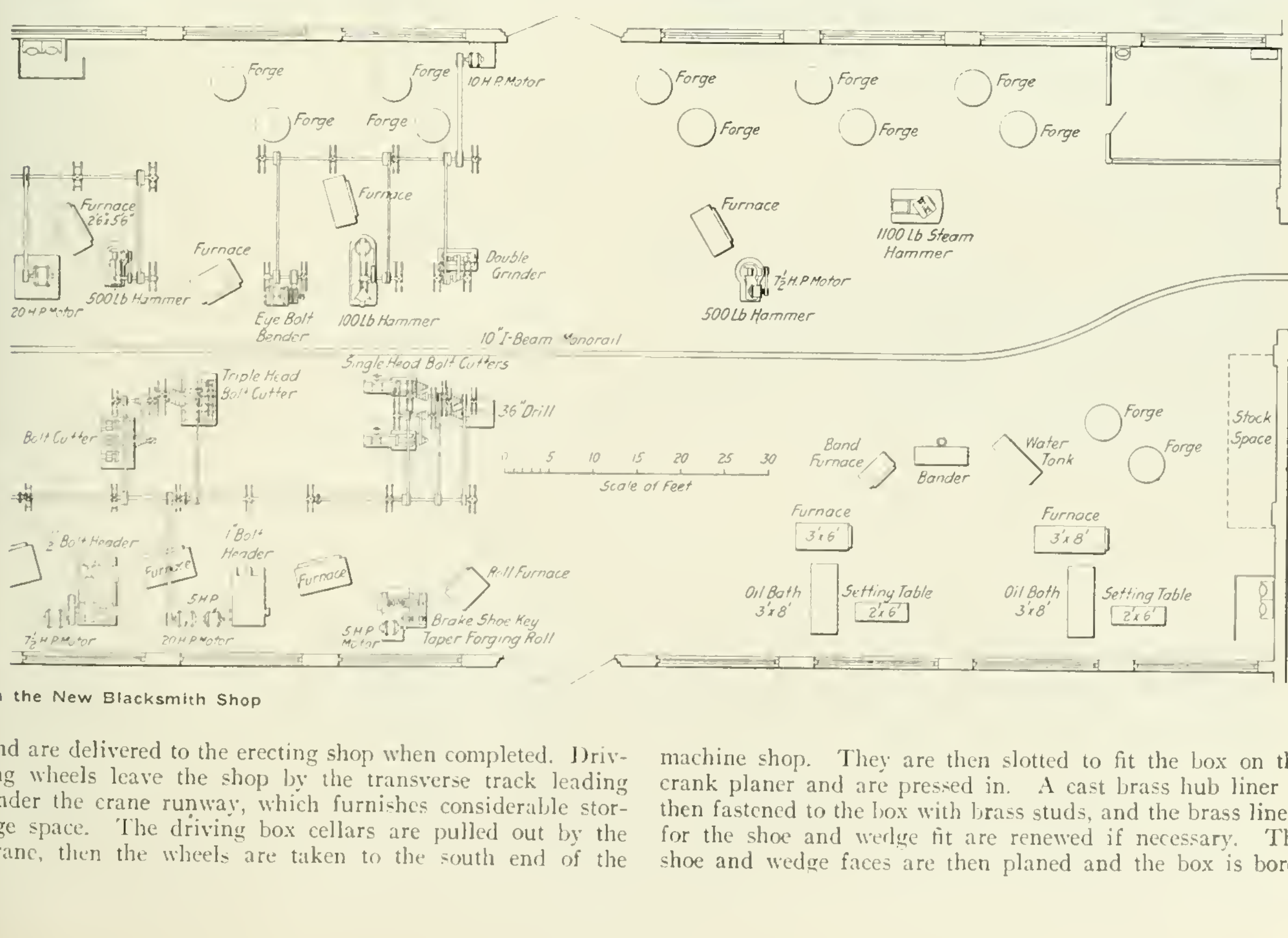


the Heavy Machine Bay

Locomotives enter the erecting shop by the center track at the west end or across the transfer table at the east end. They are stripped on this track and are then set on either of the two side tracks, each of which is long enough to hold four Mallet locomotives and two non-articulated engines.

In general, the parts removed for repairs follow a definite course through the machine shop or the heavy machine bay ing box and very little facing on the driving wheel hubs is necessary.

The driving boxes after being cleaned in the lye vat are brought into the heavy machine bay and pass to the 100-ton vertical hydraulic press, where the crown brasses are removed and the hub liners cut off. New brasses are turned on a vertical turret lathe in the



In the New Blacksmith Shop

and are delivered to the erecting shop when completed. Driving wheels leave the shop by the transverse track leading under the crane runway, which furnishes considerable storage space. The driving box cellars are pulled out by the crane, then the wheels are taken to the south end of the machine shop. They are then slotted to fit the box on the crank planer and are pressed in. A cast brass hub liner is then fastened to the box with brass studs, and the brass liners for the shoe and wedge fit are renewed if necessary. The shoe and wedge faces are then planed and the box is bored

and faced, the grease grooves being cut before it is removed from the chuck. Some boxes have the crown brass and hub liner cast in place. This work is done in the brass foundry, the boxes being returned to the heavy machine bay for boring and facing.

Main and Side Rods

The main and side rods after being stripped are placed on trestles in the machine bay. The bushings are removed with a hydraulic press and new bushings turned on the vertical turret lathe are pressed in.

New rods coming from the blacksmith shop are first milled on both sides on the slab milling machine. They are then taken to the lay-out table and the outline is laid out. The edges are then finished on the vertical milling machine and the slotter, except that the main section of the rod is finished on the slab milling machine. The holes for the bushings are then drilled on a two-spindle rod boring machine. The pistons and rods, valves and link motion are handled in the old machine shop, on tools and fitting benches grouped near the north end of the shop.

The new erecting shop is used exclusively for Mallet and heavy non-articulated locomotives. The lighter power is dismantled in a stripping shed at the south end of the machine shop, the engines being transferred to the 16 pits in the old machine and erecting shop or the two pits in the machine bay of the new shop by means of the transfer table, which has been rebuilt and enlarged to facilitate handling heavy locomotives.

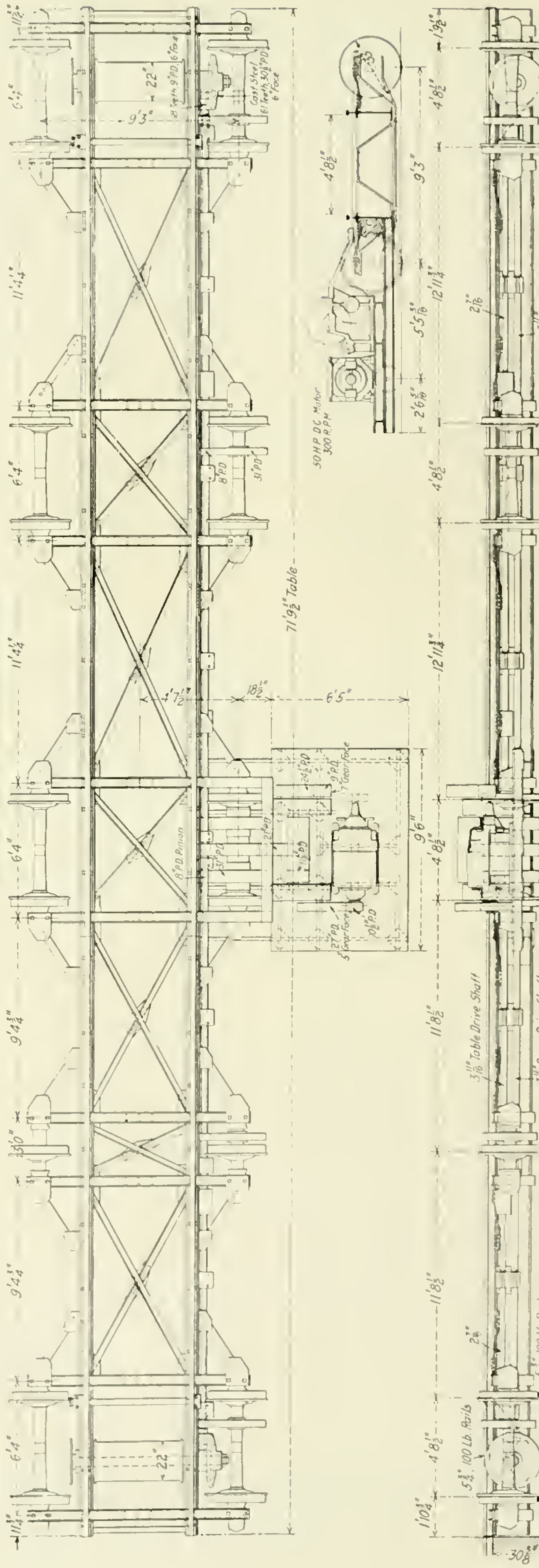
A Section of the Interior of the New Blacksmith Shop

Blacksmith Shop

The blacksmith shop occupies a brick building at right angles to the new erecting shop and an addition on the west side of the original blacksmith shop, which forms part of the new construction. The new building is 290 ft. by 72 ft., of the same type of construction as the erecting shop.

The heavy parts and locomotive work are largely handled in the older building. In the new shop are located the spring department and the facilities for handling the blacksmith work for cars. All the tools in this section are motor driven. A monorail crane running down the center of the shop facilitates handling heavy parts. The spring department is located at the extreme eastern end of the shop. A series of furnaces and forging machines is located along the center portion of the south wall. Adjacent to them are drill presses and bolt threaders, this arrangement making it possible to finish many of the parts completely before they leave the shop. Along the north side of the shop are six forges and near them are placed one 1,100 lb. steam hammer, Beaudry hammers and Bradley hammers.

The west section of the shop is equipped for making steel car parts. In this section are three combined punches and shears, one 4-spindle arch bar drill, two bull-dozers, a horizontal punch and a pneumatic straightening press, besides the furnaces necessary for heating the work.



Powerful Transfer Table at Huntington Shop

Directly south of the blacksmith shop is a shed where bars are stored. Just outside one of the doors is a shear house where bolt stock is cut to length before being brought to the blacksmith shop. In this building there are a combined punch and heavy bar shear, a light bar shear and a washer press for manufacturing washers from scrap material.

The boiler and tank shop is located east of the turntable pit and has 16 transverse tracks. The north end of the shop is used for pipe and sheet metal work and an addition at the northeast corner is equipped for handling tubes and flues. The boiler shop tools are located along the east wall of the shop and are served by a monorail crane. The tracks are

East End of the Brass Foundry

used principally for repairing tenders, as it is the practice to cut and flange the firebox sheets in the boiler shop and to assemble them within the boiler in the erecting shop, where they are welded and riveted.

Power House

The power house has six 275-hp. Sterling boilers, carrying 150-lb. pressure. Four of the boilers are fired with natural gas and two are fitted for burning coal and shavings, in order to provide for disposition of the refuse from the planing mill. The boilers are completely equipped with steam flow meters and are fed through a Cochrane metering heater fitted with a graphic recorder. An additional open heater is located in the basement of the power house and a cooling tower is placed outside of the building.

In connection with the installation of the second heater a unique method of testing boilers in the erecting shop was installed. The feed pumps connected to the open heater now lead through a main to the erecting shop. A pressure of 125 lb. is carried on this line and in case boilers are to be tested this pressure is raised to the desired amount by two portable electric triplex pumps in the machine shop.

The electric generating apparatus consists of two 750-kw. Curtiss turbines, direct-connected to an alternating current generator, with a capacity of 1,120 amperes at 480 volts. There is also a 25-kw. turbine for excitation and a motor generator set driven by a 35-hp. induction motor. The direct current required for the shops is furnished by a motor generator set of 250 kw. capacity. Compressed air is provided by two steam driven compressors, with capacities of 2,130 and 3,300 cu. ft. per minute, and a motor-driven compressor, with a capacity of 1,730 cu. ft. per minute.

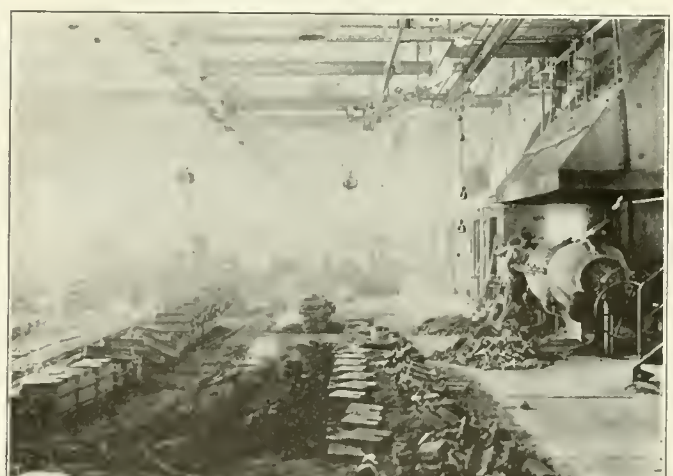
The first stage of construction included a general rearrangement of service pipe lines and electric transmission lines to serve the new shops. An addition to the engine room of the power house was built to provide for the installation of the 1,730 cu. ft. capacity direct connected synchronous motor driven air compressor.

Brass Foundry

The brass foundry is located in a new building, which is situated at the extreme west end of the shops. The building is of concrete and brick construction with a double monitor roof and is 288 ft. long by 58 ft. wide. The location is convenient for receiving material and is also adjacent to the freight car repair yard, where a large number of brasses are used. The finished material going to the storehouses is readily handled on electric trucks; that shipped to outside points is loaded directly into the cars at the brass foundry.

The extreme western end of the foundry is used for coke storage and adjacent to this is a row of eight pit furnaces for melting in crucibles. The core ovens are located at the sides of the furnaces. The molding floor extends from the furnaces beyond the center of the shop and on the north side there are two Rockwell and one Monarch tilting furnaces fired with natural gas. Along the north wall on either side of these furnaces is a series of bins with doors opening outward, thus making it possible to unload the scrap brass directly from the cars into the bins. A magnetic separator is placed adjacent to the bins used for brass turnings. A monorail track carrying a one-ton hoist is installed in front of the scrap bins and the two sets of furnaces. Another track forms a loop over the molding floor. In addition to this the molding floor is served by six small cranes with one-ton chain hoists.

At the eastern end of the molding floor there is a pair of Nichols molding machines and a Berkshire molding machine, all of which are used for making journal bearings. Just east of the molding floor is the section in which the bearings are babbitted and other castings finished. Two tumbling barrels are located in a small lean-to on the south side of the shop. Along the south wall are located a sprue cutter, two stand grinders, a two-spindle boring machine, a swing grinder and two babbitt furnaces. These furnaces are used for babbitting crossheads and similar work and two other



View Looking West in the Brass Foundry Showing Molding Floor and Tilting Furnaces

furnaces are provided at the north side of this section, one of which is used for melting off the babbitt and the other for tinning and babbitting journal bearings. The extreme eastern end of the building is used for storage of the finished castings. For convenience in loading outgoing shipments the room is provided with a pneumatic elevator. A dial scale is used for weighing castings. The space above the casting storage room is used for the storage of patterns. Adequate provision has been made for the comfort of the workers. Above the scrap bins east of the tilting furnaces are located locker rooms and shower baths. This foundry has a capacity of 15 tons daily and supplies brass castings for both cars and locomotives for the entire C. & O. system.

All In A Day's Work*

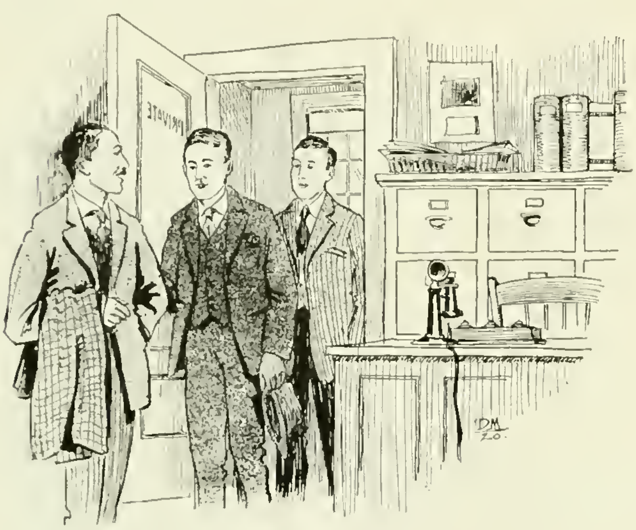
Hot Boxes, Derailments and the Grievance Committee Add Interest to the Life of the General Foreman

BY M. S. ROBERTS

EARLY one morning during the recent severe winter weather, I called at the office of a general car foreman at a busy terminal, to investigate with him certain conditions which were causing an epidemic of hot journals on through passenger trains.

I had known John Swinton, the general foreman, for many years, and so walked, unannounced, into his private office, where I found him busy at the telephone, getting a line on train detentions from the dispatcher, and, judging from the appearance of his memorandum pad, there had been a considerable number.

"Jim," said John, after greeting me most cordially, "it looks as though we would have to give the cars on trains 1



In a Few Minutes John and the Committeemen Came Out of His Office

and 15 extra careful attention for a few days, because these two trains have been performing"—Here the telephone demanded immediate silencing.

"Hello, chief; this is Swinton talking."—"What do you say? Broken arch bar on the wrecking derrick! Fine business. They were just returning from a derailment at ZX to clean up a bad mess in our passenger storage yard."—"Did Jones tell you how long it would be before he could move?"—"Good! One hour's delay won't tie us up here too badly, and I will say that it certainly pays to carry these repair parts on the wrecking outfit."—"Sure thing, you can see what it would mean if we had to send the arch bar out to ZX from the terminal."—"Good-bye, chief."

"Well, Jim," resumed John, "getting back to our hot journals. I was about to say that trains 1 and 15 burned things up pretty badly again last night, and you and I had better camp out on the equipment this morning to see if anything is being overlooked in the yard. Let's start now while the going is good."

On the way out we met the grievance committee coming in to see John, so he asked me to make myself comfortable in the outside office while he heard the men's complaints. The session was surprisingly brief, for in a few minutes John and the committeemen came out of his office. They were all apparently quite happy and it seemed probable to me that the men had carried off most of the honors in the argument.

"John," I remarked, "it did not take the boys long to put it over you that time."

"You are quite wrong, Jim," said John, smiling, "for it was more nearly the other way around. Two cases were discussed: the first one involved a shortage in a man's back pay adjustment, due to an oversight on the part of our timekeeper, and will, of course, be promptly adjusted; the second case presented proved to be without foundation, and after I had read and explained a couple of the rules of the National Agreement to the committee, they admitted their error and promptly withdrew the grievance. So you see, Jim, the meeting was mutually satisfactory."

"This is certainly a surprise to me," I exclaimed, "and if it is a fair sample of your sessions with the grievance committee, you certainly are more fortunate, or probably more diplomatic, in handling men than are many supervising officers of my acquaintance."

"I don't know about the diplomacy part of it," laughed John, evidently pleased by what I had said, "but I do know that boys here have a very fair attitude toward the company, and they seem very willing to be set right when they make errors in applying the many orders, supplements, amendments, addenda, interpretations, rules and docked decisions, with which we have had to struggle during the past eighteen months. They are not apt to present grievances until they are reasonably sure of their ground, and for this reason, I believe, do not spend their time and waste mine by following me around the territory bringing up petty grievances."

"On the other hand," he continued, "we have made an honest effort to line up to all the awards and agreements covering wages and working conditions. The men know our attitude and feel that they have been given a square deal. Confidentially, I feel that dealing with the men through their committee has been to my advantage rather than the contrary, because the disciplinary effect of this method on the rank and file has, so far, been wholesome. Of course, I probably would feel very different if the committee members were inclined to be radical, but, fortunately, these men have, up to the present time, proved themselves to be very fair minded and reasonable."

I was most interested to hear what John had to say on this important subject. There is no doubt in my mind that his success in dealing with his men is the result of his broad-minded attitude toward them, to which they naturally responded in kind.

Without further interruption, we proceeded to the passenger storage yard and began making our inspection of the journals, bearings and packing on the equipment which had been causing so much trouble of late.

Several journal bearings were found which showed signs of linings starting to crush out at the sides, and, on removal, most of them proved to have linings slightly cracked along the crown. I was strongly of the opinion that this condition was caused by excessive pounding due to lack of resilience of the track on account of the severe cold weather and deeply frozen roadbed; all of which resulted in subjecting the jour-

*Entered in the *Railway Mechanical Engineer's* prize story contest.

nal bearings to an abnormal shock, and the consequent cracking of the weakest part thereof, namely, the linings.

John agreed with me, but pointed out another serious feature, which he claimed to be at least an important contributing feature in causing the hot journals. The journal box packing now being furnished as a substitute for long fibre wool waste is of a very inferior quality. It disintegrates after a few days' service and becomes very soggy, and, in this condition, soon resembles soft mud. Lubrication, under these circumstances, becomes questionable and there is little doubt that many hot boxes can be charged to this kind of packing.

We discussed this matter thoroughly and decided, until such time as a better grade of packing became available,

John Agreed With Me, But Pointed Out Another Serious Feature

to use a mixture of reclaimed long-fibre wool packing with the inferior grade of packing now in stock, because some benefit could be secured from the springy action of the old packing and it would, at the same time, result in better capillary transmission of the oil to the journals.

We had just about completed this inspection and had made arrangements to repack all the journal boxes on the two trains, when a messenger handed John a rush communication. After reading it he said, "It looks, Jim, as though we would have to part company for the rest of the day, because the pleasant tidings which I have just received direct me to meet one of the federal inspectors, right away, and to accompany him while he makes an inspection of freight car repairs on the repair tracks. If I can get away from him on time, I am expected to attend the regular monthly safety meeting in the superintendent's office this afternoon."

I then suggested that I would gladly look over more of the passenger cars and would let him know later in the day whether I had anything more of a remedial nature to offer.

"Thanks, old man," he said, evidently relieved at my suggestion, "I hate like the mischief to leave you this way, but it is mighty fine of you to give me the benefit of your experience, and I trust that you can spare the time to go over the other trains. Well, so long, Jim, I must hurry now. It would not do to keep my friend from Washington waiting."

Shortly before six o'clock that evening, I went back to the general foreman's office, half expecting not to find him there so late. But he was in, apparently having arrived there just ahead of me, for he was looking over a couple of reports which covered the day's output of the freight and passenger repair tracks.

After briefly telling him what I had observed in connection with journals and lubrication since he left me, earlier in the day, I asked him if he had reached the safety meeting in time. "Yes, indeed," he answered, "I was able to satisfy the Federal man in a very few minutes. He was interested, principally, in keeping light repair cars moving from the repair tracks promptly. We have been making a campaign on this very thing for several weeks past, and our records showed to his complete satisfaction that, practically without exception, no light repair cars are being held over night. So he did not stay long with me, and I had just time enough left to get a bite to eat and to make the safety meeting on time.

"Jim, you have certainly put in a very full day, and I appreciate the assistance you have given me. There is a train leaving in about ten minutes, and you had better start for home," he urged, "or else your good wife will think some accident has befallen you."

"You had better call it a day yourself, John," I argued.

"Not for a little while, yet," he said, "I will go as far as the station with you, but I still have to see the night foreman for a few minutes and then I will go home."

"I don't suppose you have many days as busy as this one has been, do you, John?" I asked.

"Why, this was what I would call an average day," he laughed, "and, if the telephone behaves at all well tonight I will consider that it has been a very satisfactory day."

By this time we had reached the station and, after bidding John good-bye, I hurried for my train.

As I traveled homeward that night, I could not help thinking how typical my friend is of the great majority of rail-

I Went Back to the General Foreman's Office Half Expecting Not to Find Him There

road operating officers—cheerful, uncomplaining, serene; most congenial when busiest; and blessed with an optimism taught by years of exacting railroad experience. There is surely romance in their day's work, even though they probably never think of it in just that way.

Mr. McAdoo's Influence.—Horatio Alger's heroes may have to look to their laurels, according to a Canadian paper. A callboy of the Grand Trunk is likely to write his career as "From call boy to president." No clock watcher is this youngster. He has just drawn a pay check for two weeks, for $109.35, the result of his overtime efforts as a call boy. At this rate he is drawing a salary on the basis of $218.70 a month, which is more than the chief clerk—his boss—receives. Several other officials admit that he is getting more than they, says our Canadian contemporary, "but they explain that the scale set in the McAdoo award is responsible for the anomaly."

Some Notes on Erecting Shop Practice

A Definite Program and Attention to Details are Essential to the Operation of an Erecting Shop

BY C. P. HUBBARD
Erecting Foreman, Hornell Repair and Construction Corporation, Hornell, N. Y.

THE purpose of this article is to enumerate the various operations performed in the erecting shop in making standard classified repairs and to recommend performances for each class of repairs rather than to describe the operations themselves. The ever-increasing size of power is emphasizing the necessity of having the back shop relieve the roundhouse of heavy repairs, and as this work generally comes under the present Class 4 and 5 repairs, these operations should be distinguished from those performed in Class 1, 2 and 3 repairs. Important betterments, such as the application of superheaters, outside steam pipes, improved cylinders or valve gears, can best be made while undergoing Class 1 and 2 repairs, as when Class 3 repairs are needed the boiler and cylinders are often in good condition and require routine repairs only.

Advance information of the condition of the locomotive should be furnished so that the necessary material will be available without delay, and a comprehensive report made from observation of the locomotive in service should accompany it to the shop. When Class 4 and 5 repairs are required the report will indicate the necessity of testing cylinders and steam pipes, but these tests should always be made when making other classes of repairs.

Dismantling can best be performed by a separate gang, who will remove, clean and deliver the various parts to the proper department with their report of defective or missing material. This gang will also make the preliminary test of the boiler and cylinders and with the inspectors report their findings.

Light Classified Repairs

While preparing for Class 4 and 5 repairs, when the removal of all drivers is not intended, a careful inspection of all parts should be made in order that nothing will be overlooked that would necessitate the further removal of drivers until the next shopping. It is considered good practice by some, whenever any driving boxes require attention, to remove the complete set for a more detailed inspection. All motion work, spring gear, brake rigging, frames and connections are to be examined and put in condition for the mileage expected. Steam chests, crossheads, cylinders, steam pipes, tubes and flues and all other parts are to be made fit, so that they will not require overhauling until the next shopping.

When all wheels are removed the shoes and wedges should be lined, as required in Class 3 repairs, with the exception that driving boxes and shoes and wedges that are in good condition may be trued up, as they should run until the next shopping before going to the expense of bringing the entire set to standard. Eccentrics should be turned if found worn over 1/16 in. and their straps reduced, if needed, or replaced if the lateral motion is in excess of ⅛ in. Engine truck and trailer truck boxes and bearings are to receive needed repairs, main reservoirs are to be tested unless the date thereon indicates that they will run until the next shopping before the test is due. Air brake equipment, lubricators, injectors, safety valves and other appliances should be cleaned or repaired, so that the engine will be able to make the mileage required without the removal of heavy parts by the roundhouse force.

Handling Heavy Repair Work

In taking up Class 3 repairs the fact should be borne in mind that the work on the parts mentioned above is the same as required for the same parts in Class 1 and 2 repairs. As full mileage is expected, the engine is to be stripped of all parts under the running board, except such frame connections as show unmistakably that they need no repairs. The frames are now to be thoroughly cleaned and whitewashed. After the frames are dry they are to be sledge-hammer tested for defects and all bolts examined and removed unless in perfect condition. Particular attention should be given to cylinder and frame splice bolts, and if doubt exists as to the condition one bolt should be removed where the question arises and examined to determine the advisability of removing further bolts. If then there is any doubt as to their condition it is better to remove all bolts, as repairs of this kind between shoppings will reflect badly on the erecting shop. All bolt holes should be trued up with standard reamers and good-fitting bolts applied. Frame crossties and pedestal braces are

now to be adjusted to fit in place, worn pedestal jaws trued up and, if needed, restored to proper shape by autogenous welding. Where spring hangers are liable to chafe the frames a steel liner may be bolted or welded in place. Particular attention should be given to the guide yoke, as generally it will be found in need of some repairs. Boiler supports will need some attention, and where shoes are used under the front they will require trueing up and lubricating. Worn draw castings can often be reclaimed by autogenous welding, but they should receive special attention in regard to the condition of the draw bar pin holes and the connection to the frames, as they are hard to repair between shoppings.

When the frames are bolted completely and the pedestal braces are in place with the jaws finished, the centers are to be laid out on the main jaws. This may be done in any recognized manner, but the prevailing practice is to use lines parallel to the frames with a straight edge set square and proving the centers by it. With the main centers located, the other centers are marked off and the shoes and wedges put in place and laid out. The importance of accuracy in this operation is very great, and accurate machining of driving boxes should be insisted on, as the engine wheels will not tram properly if poor work is allowed. A standard proof mark on the shoes and wedges will determine if any liners are required, and in planing, if the shoe or wedge will not true up to the proof, it should be planed so that one liner of standard size boiler steel, not less than 1/8 in. thick, may be used, this liner to be securely riveted in place.

All spring rigging should be thoroughly overhauled, attention being given to see that the saddles set square on the driving boxes. After spring rigging has been repaired and reapplied, the frames and spring rigging may be painted and the engine is ready for the wheels.

Details That Require Special Attention

If the cylinders do not need renewing they should be bored if out of round 1/16 in., or bushed if they will not true up to 5/8 in. over the correct size. Valve chamber bushings should be bored to 1/8 in. oversize or renewed if already oversize, and packing and bull rings should be carried in stock in these sizes. If slide valves are used the seats should be trued up until they reach 1/8 in. thickness, when they are to be faced flush and false seats applied. Slide valves that have reached 5/8 in. or less in thickness are to be renewed and the pressure plates are to be lined and planed true, so that there will be 1/8 in. clearance when drawn down in place. Guides should be carefully lined, so that the crosshead will be central with the bore of the cylinders and straight bolts fit to a light driving fit and single liners should be applied to hold the guides in place.

When the boiler work is complete, the test made and defective flues replaced, the steam pipes applied and all mountings applied to the boiler, it should be charged with steam or compressed air and the steam passages should be blown out, after which the ports should be examined to locate lodged foreign matter. This done, the steam chests should be closed and the passages to the cylinders blown out by placing the valves in the forward and back positions. The pistons and cylinder heads may now be applied and the stroke of the piston measured, making sure that the piston will have at least 1/2 in. clearance over all.

It is advisable that all work possible, such as the application of air pumps, stacks, sand boxes, bells, generators, cabs, injectors and the like, be handled as early as possible in the erection of the engine in order to avoid the confusion of a large number of men working close together when the engine is nearing completion.

Main reservoirs are due for hammer test at the time when heavy repairs are made, and should be replaced if found defective. A 16-in. reservoir is to be condemned if any part is 3/32 in. or less in thickness, 18 in. to 20 in. reservoirs if 9/64 in. or less and 22 in. and over if 3/16 in. or less, or if any reservoir will not stand 170-lb. hydrostatic pressure.

All brackets or other attachments to the boiler should be left securely fastened in place, special attention being given to these particular parts when the lagging is off the boiler.

Engine truck and trailer trucks should be well built and should have not over 1/4-in. lateral motion when new, the same rule applying to driving wheels.

Planning the Final Operations

After wheels and trucks are applied, shoes and wedges are put in place and the wheels trammed. They will tram if all the work is correctly done, and the wheels should be parallel to lines run parallel to frames, as was done when main centers were laid out. After any errors are corrected, the pedestal braces may be bolted in place and the ash pan, brake rigging and other parts underneath the engine applied.

The motion work should be applied by this time and it should hang free, being without any cramp or strain. The subject of valve setting has been dwelt upon so much that it is not necessary to discuss it here, except to say that this work should be done according to instructions from the proper authority and should not be left to the judgment of the man who does the work. With the valve setting complete and adjustments made, the rods are ready to be applied and adjusted for the proper travel.

With the last details complete, the engine leaves the shop, the tender is coupled and the engine fired up. The pop valves are set, the air brakes adjusted and the engine is run a few revolutions, with the cylinder cocks out to make sure that the cylinders are clean. The engine should make the trial trip with the cylinder and steam chest casings off, the better to locate any leaks that may develop.

In order that all the details necessary to the operation of the erecting shop may be successfully performed, it is necessary that some definite program be adopted. The subject of scheduling or routing deserves serious attention, but the successful operation of the shop depends upon the co-operation of all departments toward that end.

Radium.—A recent issue of the Scientific American contains an interesting account of radium. It is stated that so far there are only three or four companies in the world producing radium commercially, and the product of the largest of these is about an ounce a year. The total amount of pure radium in the world today is only about five ounces, the market value being $120,000 a gram, which is one twenty-eighth of an ounce. Only two practical uses have so far been discovered. The first is for medicinal purposes and the second is in the production of the luminous material used on watch and clock dials and as locaters for electric switches, etc. Already more than 4,000,000 watches and clocks have been treated and hardly a third of an ounce of radium has been used in the production of all of the luminous material required. In making this luminous material zinc sulphide or crystallized zinc is used as a base. The glow is caused chiefly by the bombardment of minute particles to which the zinc is subjected in the presence of radium, and it is necessary to have the zinc sulphide of great purity. The largest of the domestic producers has its mines in Paradox valley, Colorado. The ore is hauled to the railroad, a distance of 58 miles, by six-horse wagons, and from there is carried by rail to a plant in Orange, N. J. The reduction process is a complicated one of chemical separation and elimination. After passing through scores of vats, strainers, compressors, evaporators and the like, about eight carloads of ore have been reduced to less than a thimbleful of radium. Considerable quantities of uranium and vanadium are a by-product of the process.

Convention of the Master Boiler Makers

Welding Firebox Sheets; Steam Pressure and Staybolt Breakage; Handholes vs. Washout Plugs

THE twelfth annual convention of the Master Boiler Makers' Association opened at the Curtis Hotel, Minneapolis, Minn., at 10 a. m., Tuesday, May 25. About 250 members were present at the opening session. The opening address was given by Hon. J. E. Meyers, mayor of Minneapolis, who welcomed the association to the city.

Following this William Schlafge, mechanical manager of the Erie Railroad, spoke of the necessity of organization in the industries, in order that productive efficiency might be increased. The duty of all boiler makers, and particularly the foremen, is to hasten the replacement of power equipment in the country by carrying on the good work which has in the past marked their efforts. During the war the principles of conservation of labor and of materials were applied with remarkable results. Machine equipment was adopted wherever possible to aid production; in other words, every effort was made to obtain a maximum result with a minimum expenditure of time and labor. The same principles must be applied to a higher degree now to carry the nation through the present economic crisis without undue hardship. Turning from their constructive duties, Mr. Schlafge spoke of the responsibilities that superintendents and all others in positions of authority have toward the men under them, in instructing them in their work and understanding their requirements. All radical tendencies must be stamped out and the sad experiences of labor in European countries prevented.

The president of the association, John B. Tate, delivered his address on power units of the future. The engineering departments of all roads must provide for more powerful locomotives—engines capable of hauling 150 cars of 150 tons each. In the present freight congestion this need for greater power has been well demonstrated. Stationary boiler design must also be improved, so that the operating efficiency may be increased and the cost of upkeep diminished. Because of the increasing tendency toward the electrification of roads, the size and efficiency of power plant units must be increased. During this reconstruction period the men who hold the responsibilities of supervision in the shops must act at all times in such a manner that decisions are entirely fair and impartial.

The remainder of the Tuesday session was taken up with reports of the secretary and the treasurer and routine business. Under the head of miscellaneous business it was voted to consider the invitation of Section III—Mechanical, American Railroad Association, for the Master Boiler Makers' Association to become a member of the organization.

Wednesday Session

The opening address at the Wednesday session was made by J. M. Hall, assistant chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission, on the causes of boiler failures. Lantern slides of disastrous locomotive explosions were exhibited. The accidents illustrated the more usual contributory causes, and in each case these were quite apparent. Low water, corrosion of plates, bad welding of seams, formation of scale in the water glass and gage cock plugs have all increased the total of locomotive disasters. Mention was made of experiments conducted by the chief inspector's office on the relative accuracy of the gage cock and water glass in indicating the true height of water in a boiler. The conclusion reached, after testing various locomotives in different sections of the country, is that a roll of water is raised at the back flue sheet which the gage cock indicates, while the water glass gives the true level of the water as four to eight inches lower, depending on the size and type of the boiler. Within a short time the bureau will issue instructions on the proper installation of gage cocks and water glasses in relation to each other and to the boiler, in order to overcome the danger from former inaccuracies.

W. H. Bremner, president of the Minneapolis & St. Louis, impressed on the members of the association the necessity for the best workmanship and inspection to keep the present equipment of the railroads at 100 per cent efficiency, for although replacements have been commenced it will be many months before many old locomotives will be eliminated. The railroads depend not on any one individual or group to maintain the standards, but upon every man in the organization, no matter what his duties may be. The same loyalty must be shown to the private companies now as while the roads were under federal control, for the nation's welfare is absolutely dependent on the service of the railroads, which is being well demonstrated at the present time.

After the conclusion of this talk the remainder of the

J. B. Tate (Penn.)
President

C. P. Patrick (Erie)
First Vice-President

Thomas Lewis (L. V.)
Second Vice-President

Wednesday session was devoted to the discussion of papers submitted by members of the association.

Relative Advantages of Handhole Plates and Washout Plugs

In the absence of a report from the entire committee on this subject, the secretary read the personal report of Charles P. Patrick, chairman of the committee.

The question as understood means, what is the best washout opening device to tighten under pressure? This question involves other considerations which must be met. Accidents, expense and terminal delays to locomotives are to be considered with the subject.

The best device to overcome leakage when the boiler is under pressure is a good-order brass plug having 12 threads to the inch and a taper of ¾ in. to the foot. These plugs must be full in size, made of good material and have four full, good-order continuous threads at least in the sheet. If these conditions are maintained there will be but little chance of material leakage, and if leakages occur there is little or no trouble or danger in tightening a good-order plug properly applied, which has from some cause or other not been made tight while the boiler was empty.

We cannot provide against neglect of sheets or plugs which cause failures and accidents. These conditions are controlled by the boiler inspectors and men in charge of the work. If the threads on a plug are bad, or the plug allowed to be used after it gets a shoulder by which it is temporarily frozen tight, or the sheet allowed to grow thin to the extent that it does not contain sufficient threads to hold the plug, or the threads bruised and battered so a plug will not tighten, an accident or engine failure may occur.

Also the brass screwed washout plug is the most economical washout opening device in use today, and there are no other removable attachments to the boiler that give less trouble or cause fewer accidents.

Discussion

Although handhole plates have been used in some cases without undue trouble, it seemed to be the consensus of opinion that a plug of good design made of brass or steel is far superior, and most of the roads in the country eliminated handhole plates many years ago. All members agreed on the standard of 12 threads per inch, but the taper used varied from ¾ in. to 1¼ in. per foot, the results, however, differing but slightly. It is possible that plugs having the greater taper are less liable to have a shoulder form, which shortens their period of usefulness.

There are no more complete data on a locomotive device in the records of the bureau than on the service of the washout plug. As to accidents chargeable to these plugs we have the following record from the Bureau of Locomotive Inspection:

"We have 69,000 locomotives coming under this department. During preceding years the accidents from arch tube and washout plugs consisted of

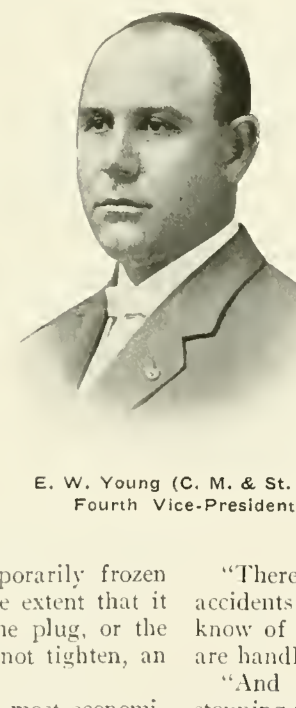
13 in 1912	17 in 1916
20 in 1913	8 in 1917
21 in 1914	14 in 1918
16 in 1915	30 in 1919

making a total of 139 accidents from all causes during the last eight years, or an average of 17.3 per year. We will assume 18 accidents per year.

"About 40 per cent of these locomotives, or 27,600, are equipped with arch tubes, and the average number of plugs in each boiler is 25. For the entire lot of engines this gives 690,000 plugs. The remaining 41,400 locomotives are without arch tube plugs; therefore have eight less, or 17 plugs per boiler, giving a total of 703,800 plugs, and a grand total of 1,393,800 plugs.

"Some water conditions necessitate the removal of plugs only once a month, while the other extreme is reached in bad water districts where as many as 10 removals a month are made. However, to be on the safe side we will take an average of two washouts a month, which means 33,451,200 washout plugs removed each year. As before stated, we have an average of 18 accidents per year, or one accident for every 1,858,177 plugs removed.

T. P. Madden (Mo. Pa.)
Third Vice-President



E. W. Young (C. M. & St. P.)
Fourth Vice-President

H. D. Vought
Secretary

"There is really no reason whatever to be alarmed about accidents from washout plugs. They are the safest device I know of on a locomotive boiler, considering how often they are handled.

"And it is also, in my opinion, the cheapest device for stopping up a hole in a boiler which has to be unstopped and restopped from one to ten times a month."

Tensile Strength of Firebox Steel

On the question of whether the best results may be obtained from firebox steel having a tensile strength from 48,000 to 58,000 lb. per sq. in., or from 55,000 to 65,000 lb. per sq. in., the committee has endeavored to make the report on the subject as brief as possible. In gathering this information we find there is a very slight difference of opinion, or rather a slight difference in the specifications of the various railroads, for firebox steel.

The members of the committee have given considerable attention to the care of locomotive boilers, including the study of failures of firebox sheets.

In general, firebox sheets fail in one of two ways:

(1) Gradual Failure: The sheet may have a good many

small cracks, which are mostly in a vertical direction. These cracks are thickest, radiating out from the staybolts and frequently run from one staybolt to another in the same vertical row, but never between staybolts horizontally. These cracks are almost always on the fire side and at times extend through the thickness of the sheet, first going through next to the staybolts. Such sheets are almost always accompanied with more or less corrugation, and the cracked and corrugated condition is almost always confined to the lower half of the sheet.

(2) Sudden Failure or Rupture: The sheets may fail by a single crack or rupture from a foot to several feet long. In bad cases the crack may extend from the mud ring to the crown sheets, but ordinarily the cracks are confined to the lower half of the sheet, extending upward from the mud ring or from a few inches above it, and it is always near the middle of the side sheet longitudinally. Such sheets may show no corrugations and may show very little if any other defects.

The failures of the first kind are of gradual formation, but those of the second class occur suddenly.

The records on file of one of the largest railroads in the United States show that between the years 1886 and 1913, 115,000 tons of boiler and firebox steel were used on locomotive boilers, and they do not have any record of any failure that resulted in injury to persons or loss of life due to the character of the material.

This same railroad in 1892 specified and adopted firebox steel with a tensile strength of 55,000 to 65,000 lb. per sq. in., and they are using the same grade today.

It is the opinion of the committee that the life of the firebox sheets does not entirely depend on the specifications or tensile strength of the material, but rather on the care and treatment to which the plates are subject; for instance, the washing of boilers with cold water before the boiler is properly cooled down; second, using the injectors when active steam production is not going on.

In conclusion, from the best information this committee was able to obtain, firebox steel with a tensile strength of 55,000 to 65,000 lb. per sq. in. gives the best results.

However, we would also add that it is our experience that by suitable treatment of water supplies, a proper arrangement for delivering feedwater into the boilers and proper methods of caring for boilers in the enginehouses and elsewhere, long life can be expected with most any grade of firebox steel.

The report is signed by W. J. Murphy, chairman; J. F. Ferestrum and Lewis Eberle.

Discussion

Opinion seemed about equally divided on the desirable tensile strength for firebox steel. Good results have been obtained with steel from 48,000 to 58,000 lb. per square inch, as well as from the higher strength of 55,000 to 65,000 lb. per square inch. It seems to be true that if the staybolts are properly applied along the fire line, crown sheet failures will be prevented. In any case the strength of steel or the carbon content have little to do with failures so long as the material is within the 48,000 to 65,000 lb. per square inch limit.

Effect of Steam Pressures on Staybolt Breakage

On the subject of superheating and reducing steam pressures in locomotive boilers and their effect on staybolt breakage, the committee submitted the following report:

The compiled data taken from six different territories or districts where the service, water condition, etc., differ largely and steam pressure is about the same, are given.

The chart shows there is no doubt that the superheater and reduction of steam pressure of boilers from 220 to 195 lb. pressure will decrease the staybolt breakage.

We have also compared 10 locomotives previously operated as saturated without brick arch. These locomotives were later equipped with a superheater and brick arch, and the pressure remained the same—205 lb.

The comparison shows considerably less staybolt breakage. (While this paper is not on the brick arch, we consider they are co-related and have some bearing on the subject.) The reduced breakage of staybolts is accounted for along these lines: The brick arch acts as an indicator, making the proper handling of the boiler compulsory. If the boiler is blown down too soon arch tubes will be distorted. Saving the arch tubes also saves the staybolts.

Data on Staybolt Breakage Covering Period of Five Years

District number	Number of locos.	Steam pressure	Total broken	Bolts broken per year	Bolts broken per engine per year
Superheater..........	5	185 to 200	127	25.4	5.08
Saturated....	5	220	514	102.8	20.56
Superheater..........	5	185 to 195	216	43.2	8.64
Saturated............	5	220	710	142	28.4
Superheater..........	5	185 to 200	1,193	238.6	47.72
Saturated............	5	220	1,848	269.6	73.9
Superheater..........	5	185 to 200	196	39.2	7.84
Saturated....	5	220	1,610	322	64.4
Superheater..........	5	185	432	86.4	17.28
Saturated............	5	220	470	94	18.8
Superheater..........	1	185 to 200	71		
Saturated............	5	220	358	71.6	14.32

All engines involved are Pacific type.

Our records show that superheating and reducing of steam pressure of boilers result in a reduction of staybolt breakage.

The report is signed by T. L. Mallam, chairman; F. A. Mayer and E. J. Sweeney.

Discussion

An individual report on this subject was submitted by T. L. Mallam, chairman of the report committee.

"The New York Central Railroad, in connection with the Pennsylvania, during 1910 made two elaborate series of tests, and the results obtained showed that superheater locomotives decreased the demand on the boiler from 25 to 35 per cent; that is to say, the boilers of the superheater locomotives have to make considerably less steam than the boilers of the other type. This is, of course, due to the fact that less superheated steam, with its greater heat content, is needed for a given power.

"In line with the results of these tests and my own experience, I contend that superheated boilers do not break as many bolts as boilers not superheated. We have in service on our road four O. G. style fireboxes that are not superheated. These four engines carry 200-lb. per square inch pressure, whereas all the others carry 180-lb. pressure. We find that more staybolts are broken in these four engines than in any eight superheaters.

"There is a question in my mind whether the lesser staybolt breakage on our superheaters is the result of the lower boiler pressure or whether it is the result of other conditions caused by superheat, design and service. As just mentioned, I think the superheater boilers do not have to make as much steam as the saturated steam boilers and therefore do not have to be worked as hard as the latter, with the result that firebox sheets are not punished as badly. The lower boiler pressures of a superheater may help, but I am of the opinion that the greater advantage to staybolts and boiler maintenance conditions from superheat is that with it an engine can be more easily fired and the steam maintained more uniformly.

"I believe everyone appreciates the fact that staybolts are caused to break by expansion and contraction, which again causes the inside and outside sheets to move with relation to each other. The harder and more irregularly the boiler is forced, the greater will be such movement and the greater the staybolt strain. The lower the factor of safety in the design, the greater becomes the chance for staybolt breakage with this strain."

The early part of the discussion seemed to indicate that

the mere act of decreasing the steam pressure by superheating to obtain the same power as with saturated steam would decrease the breakage of staybolts. However, the problem is not quite as simple, for staybolt breakage depends on a variety of independent factors. The steam must, of course, be considered, but so also must the type of service, the general topography of the country in which an engine operates, the quality of the water used, and above all the state of repair of the locomotive. To gain even an approximate comparison between superheated locomotives and those utilizing saturated steam, engines of the same type in the same sort of service and the same condition of repair must be used. The nearest approach to such a comparison came from a representative of the Georgia Railroad, in whose charge are eight locomotives fulfilling the above conditions, four of which are superheaters and the other four use saturated steam. From accurate records of the staybolt breakage on these eight machines there does not seem to be a bit of difference. The final conclusion reached is that the design of a locomotive and its service and care have all to do with staybolt breakage.

Cinder Hopper on Bottom of Smoke Arch

From inquiries and observations made, the committee finds that the use of a cinder hopper on the bottom of the smoke arch is quite varied. There are roads that have some of their engines equipped with a hopper, and others not so equipped, and their performance is also varied; some engines with the hopper as well as those without it clean themselves satisfactorily and steam well, while other engines of the same class and type, having the same design and adjustment of front-end appliance set alike, do not perform as well, accumulating such an amount of cinders in the front end that it is necessary to clean them out while on the road and away from the terminal.

The committee is aware of the fact that with some grades of coal the front end fills up to a greater extent than with other kinds, and to facilitate the removal of cinders the hopper is a convenience, if not a necessity. However, its use or non-use depends largely on local conditions, kind of fuel and grade of coal used. We incline to the opinion that it is not necessary to maintain the hopper on oil-burning nor on coal-burning engines that have front-end draft appliances so designed, fitted and adjusted that they will clean themselves without danger of throwing sparks of such size and glow that they cause fires on the road.

Our inquiries further indicate that the foregoing also applies equally as well to the second part of the subject, "On what size locomotives should it be maintained?" and that the use of the cinder hopper is about evenly divided between the larger and smaller classes of engines on the various railroads.

In regard to the third question of the subject, viz., "Which is the better design to overcome air leaks?" we find that there are a number of different designs used by the various roads. Some have hoppers with a double nozzle lengthwise of the smoke arch, others a double nozzle transverse with the arch, the cover held in place by a bolt and spring between the nozzle, while on others a single nozzle with the cover hinged so it will drop down, or one that opens to one side, is used. Again, others have the single nozzle hopper, the cover being of wedge shape. As it is of great importance to keep the front end as free as possible from air leaks, it is our opinion that the single nozzle hopper with the cover plate fastened on each side is a better design.

The report is signed by Frank H. Davison, chairman. Thomas J. Reddy and John L. Welk.

Discussion

The need of the cinder hopper on the bottom of the smoke arch has long since been eliminated by most roads. In its place a standard form of non-adjustable, self-cleaning front end has been applied. In some instances a patch is riveted under the smoke arch and a two-inch washout plug arranged to take care of any leakage from the pipes or superheater tubes.

Flanging of Firebox Sheets on the Flange Press

The committee reported that the flanging of firebox sheets on a flanging press is not detrimental. It is a matter of the proper heating of the material.

Cold flanging can be successfully employed on round heads and straight sides of flue and door sheets in all types of fireboxes.

The report is signed by Robert C. Gibson, chairman.

Thursday Session

A short talk was given by A. H. Kipp, mechanical superintendent of the Soo Line, on the duties of the members of the association to the country. Following this the discussion of papers was resumed.

Electric and Oxy-Acetylene Welding of Firebox Sheets

In the absence of a report, Prof. A. S. Kinsey, in charge of welding and shop practice at Stevens Institute of Technology, gave a general survey of the present standing of autogenous welding and the future prospects of its recognition as a permissible process of boiler construction.

Professor Kinsey had just been present at the St. Louis meeting of the American Society of Mechanical Engineers, at which a prominent insurance company requested that the Boiler Code Committee, of which Professor Kinsey is a member, allow the use of autogenous welding in stationary heating boilers generating steam up to 15-lb. pressure. The Boiler Code Committee is considering this petition seriously and will probably report favorably on it. In connection with this subject the A. S. M. E. Boiler Code Committee has appointed a sub-committee to investigate the matter of welding seams in boilers and pressure vessels with a similar committee from the American Welding Society.

Forge welding has been allowed a rating of 52 per cent, or a permissible load of 52 per cent of the strength of the metal, by insurance companies. Although autogenous welding is not recognized as yet, there is no reason why fusion welding cannot be made very nearly as strong as forge welding. As a matter of fact, an increase in the rating of forge welding from 52 to 75 per cent is now being considered by the A. S. M. E. If every one interested in advancing the process is united, first of all, in demanding the best welds possible in the shops where the process is used and then in advocating its adoption and recognition by the insurance companies and the A. S. M. E., there can be little doubt of the outcome.

From consultations with A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, and from extensive examinations of defective welds taken from exploded boilers, Professor Kinsey stated that they were some of the worst welds he had ever examined and that they had done a great deal to retard the advance of the process.

The development of autogenous or better fusion welding has nearly reached the point where it is possible to weld manganese steel frogs on rails. Firebox plates can be welded as safely as they can be riveted by either the electric arc or acetylene torch. Any weld may be easily made to lose its strength by burning or oxidizing the metal, and this is the greatest defect to be combated in the operation of welding.

Two rules should be followed in welding. The grain of the metal should be so refined as to come back to its original size and, in the case of steel, the weld should be annealed. When recognized by the A. S. M. E., this requirement for annealing will probably be inserted in the rules for permissible welding procedure.

At the St. Louis meeting of the A. S. M. E. the safe-ending of boiler tubes was discussed at one of the Boiler Code Committee sessions, and the records were consulted to determine

if welding were allowable in this case. It was found that it is permissible to weld the safe ends of tubes in fire tube boilers but not in water tubes, which means that locomotives may use it in this connection.

Discussion

The criticisms brought out at the last convention have served their purpose in arousing the interest of all members of the association, and no doubt the fewer accidents from the letting go of welded seams may be due to the closer supervision of all welding in railroad shops. However, if the reports of the Bureau of Locomotive Inspection continue to show any disastrous explosions from the failure of welded seams, it will be a difficult matter to obtain an early official recognition of the process.

A short paper on the procedure used in electric arc welding was given by one of the members.

On the Santa Fe the welding departments of all shops are required to send test specimens of their work to the laboratories to be tested to destruction. The seams are reinforced about 20 per cent and when pulled average about 83 per cent, which is about what is obtained with riveted joints. One instance was cited of 29 specimens taken out of plates after being in service 4½ years, which tested 71 per cent.

As on all other questions, opinion was divided. Certain members advocated great caution in adopting the process, particularly where human life depends on the quality of the work. So long as there is a doubt as to the safety of a seam, and certainly until disasters from weak seams have stopped, it is well to avoid the extensive application of autogenous welding. The discussion turned from welded seams to the welding of flues. In certain sections of the country it was found that electrically welded superheater flues cracked, while smaller tubes were not found to do this. In still other districts leaks are found in both superheater and smaller flues. In bad water districts, scale forms in pockets around the flue end, and by preventing the cooling effect of the water, permits the heat to crack the tube. This applies to the side sheet, under the arch as well as where the heat is intense. When staybolts are calked where they enter the side sheets, pin cracks are started if the water does not circulate properly. Flues should be prossered in bad water districts.

Where welds have been found sound in good water districts, a few months with hard water have only been necessary to allow the formation of cracks. The conclusion seemed to be that in good water districts welded flues remained tight, while bad water tended to hasten the formation of cracks in safe ends.

The subject of welded patches was barely touched upon without any definite decision as to their use.

Best Style Grate for Bituminous Coal

No report was submitted by the committee, but a brief outline of the use of the box grate was presented by William Stinsky. In the course of the discussion it was stated that the time is rapidly approaching when the dump grate will be eliminated from both ends of the firebox. The best results have been obtained with box grates having a width of nine inches. If a dump grate is used it must be kept from under the flues, for if used in this position all sorts of leakage and trouble result.

The draft opening in the ashpan was brought up for discussion, and the opinion seemed to be general that at least 15 per cent of the grate area should be opened in the pan to obtain complete combustion of fuel. Even with the opening in the pan, sufficient flues must be installed to carry off the gases. Side openings and center openings have been tried, and netting has been used in the pan, all bringing about good results where used to fill certain operating requirements.

Box grates up to 11 in. wide have been tried and minimum openings of 18 per cent, with varying degrees of success. The standard, however, seems to be a nine-inch grate and a 15 per cent ashpan opening.

Following this the annual election of officers was held.

Officers for 1920-1921

President, Charles P. Patrick, Wilson Welding Repair Company; first vice-president, Thomas Lewis, Lehigh Valley; second vice-president, T. P. Madden, Missouri Pacific; third vice-president, E. W. Young, Chicago, Milwaukee & St. Paul; fourth vice-president, Frank Gray, Chicago & Alton; fifth vice-president, Thomas F. Powers, Chicago & North Western; secretary, Harry D. Vought; treasurer, W. H. Laugbridge, Hocking Valley.

Executive board for one year: L. M. Stewart, Atlantic Coast Line; John F. Raps, Illinois Central; John Harthill, New York Central. For two years: W. J. Murphy, Pennsylvania Railroad; Harry F. Weldin, Pennsylvania Railroad; E. J. Reardon, Interstate Commerce Commission. Three years: B. F. Sarver, Pennsylvania Lines; George Austin, Santa Fe; H. J. Wandberg, Chicago, Milwaukee & St. Paul.

DRILLING RECORDS MADE AT ATLANTIC CITY

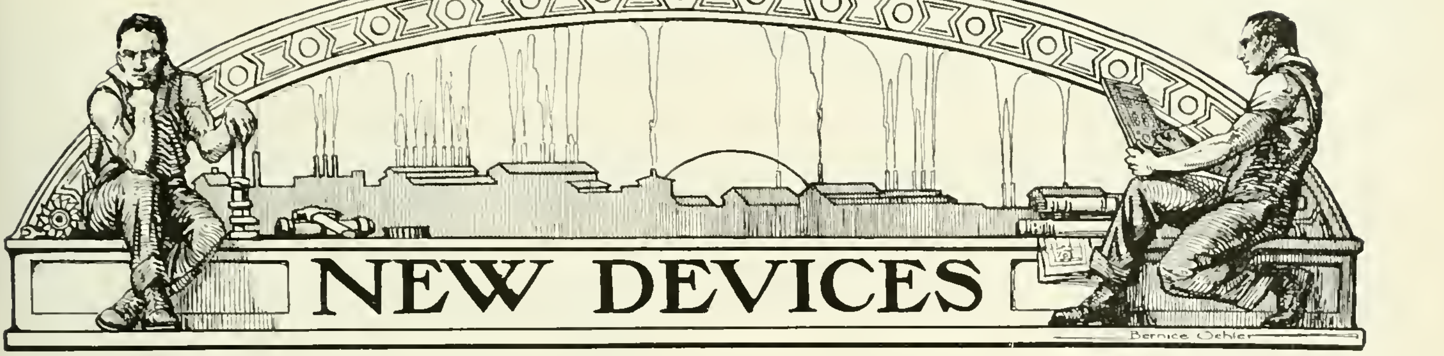
Drilling demonstrations with Cleveland milled high speed drills were conducted during the annual June convention of the American Railroad Association, Sections III and VI, at Atlantic City. Several records were made in these tests and it is reported that records made in 1911 were completely shattered. On June 15 and 16, milled high speed drills were forced through cast iron at the rate of 6 ft. per minute and through machinery steel at the rate of 2½ ft. per minute. Details of speed, feed, etc., are given below.

Material	Dia. of drill	R.p.m.	Feed in. per rev.	Number of inches drilled	Vol. lb. removed
3 in. cast iron.........	1 in.	720	.100	9 in.	14.74
3 in. mchy. steel.......	1 in	600	.050	3 in.	6.60
3 in. cast iron.........	1¼ in.	720	.100	15 in.	23.01
3 in. mchy. steel.......	1¼ in.	500	.040	3 in.	7.00

It is evident that the above records could not be recommended for commercial shop practice as few, if any, shops would have the press equipment or power to duplicate them. For example, in making the record in cast iron with a 1-in. drill, a feed of .100 in. per revolution and speed of 720 R. P. M. were used. Good shop practice would indicate a speed no greater than 267 R. P. M. and a feed of .015 in. per revolution. In the tests shown above, both the feed and speed exceeded normal practice. The same statement applies to the record in machinery steel. Demonstrations, like the above, show the tremendous reserve in the modern high speed milled twist drill. Stock drills were used in the tests and the drills were driven by a Foote-Burt heavy duty drill press.

Additional drilling tests were conducted in open hearth chrome nickel steel using Hercules high speed drills made by the Whitman & Barnes Manufacturing Company, the power being furnished by a 6 ft. American radial drill. The results of these tests showed conclusively that hard and tough alloy steels can be drilled on a production basis and economically. The chemical analysis of the steel showed .50 per cent carbon, .90 per cent chromium, 1.00 per cent nickel and .75 per cent manganese. Holes 3 in. deep were drilled in nine seconds with 1 in., 1⅛ in. and 1¼ in. drills attaining a penetration of 1 in. every three seconds. The following is a summary of the data secured in these tests:

Material	Dia. of drill	R. p. m.	Feed in. per rev.	Time per hole	Average No. holes per grinding
3 in. alloy steel..	1 in.	500	.040 in.	9 sec.	32
3 in. alloy steel..	1⅛ in.	500	.040 in.	9 sec.	24
3 in. alloy steel..	1¼ in.	500	.040 in.	9 sec.	27
3 in. alloy steel..	1½ in.	500	.029 in.	12½ sec.	29
3 in. alloy steel..	2 in	206	.040 in.	22 sec.	27
3 in. alloy steel..	2½ in.	206	.022 in.	40 sec.	12



Right Line Radial Drilling Machine

RIGHT line radial drilling machines built in either full universal or plain types and with five-foot or six-foot swing have been developed and placed on the market recently by the Niles-Bement-Pond Company, New York. These right line radials embody somewhat radical changes from the usual type of radial drill. The drive has been simplified so that a high percentage of the driving power is delivered to the spindle. A general view of the machine, Fig. 1, indicates the entire absence of belts and the reduction of driving gears to a minimum. A feature of the new drill which adds to the rigidity of the machine and simplicity of drive is the patented double column arrangement, a cross section of which is shown in Fig. 2. This arrangement allows for direct drivo from the motor to the spindle through the double column also shown in Fig. 3. The column is a single casting formed of two box section members cast integral at the top and bottom, the arm saddle being mounted between them. The motor is mounted on the back of the arm saddle and drives the spindle through a single horizontal shaft running between the column members.

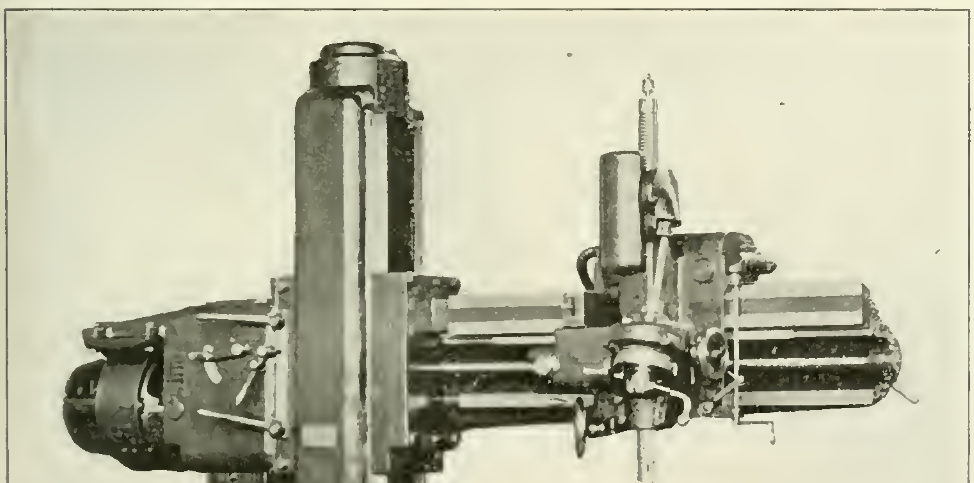


Fig. 1—General View of Niles-Bement-Pond Right Line Radial Drill

Since the column is not stationary, but rotates with the arm, it has been possible to place the metal to the best advantage in the form of a patented beam section. Bending stresses in the column are always in the direction for which this section is designed. Another advantage of this type of column is that it permits the use of vee tracks at the front and back for guiding the arm saddle. When clamped by means of a wedge connection on these tracks, the arm and column form a rigid unit. Instantaneous clamping of the column to the pedestal is obtained by means of a motor operated device shown in Fig. 4. This device is both simple and convenient in operation and the clamp is engaged and disengaged by throwing a switch located on the control head. It is not necessary for the operator to leave his working position. A lever for clamping by hand also is provided. The electric clamp is operated by a small motor with one wheel, the mechanism being self-adjusting. The arm is especially easy to swing, its entire weight being supported on a ball bearing at the bottom of the column. When clamped, a broad metal to metal contact makes the column and pedestal practically one piece.

The maximum resistance to drilling pressure is secured by a specially designed arm cross section as shown in Fig. 5. With the upper narrow guide for the saddle and the lower bearing set in a plane back of the front surface, the driving shaft is brought closer to the spindle and a greater depth is secured from the front to the back of the arm. Under heavy drilling strains, this design tends to eliminate the deflection of the column and arm structure.

The arm is raised and lowered by power from the driving motor, the mechanism being engaged by throwing the clutch lever located on the driving gear box. The machine is started

and stopped by means of a controller handle on the control head. The elevating and clamping mechanisms are interlocking and cannot be engaged simultaneously with resultant damage to the machine. An automatic stop to pre-

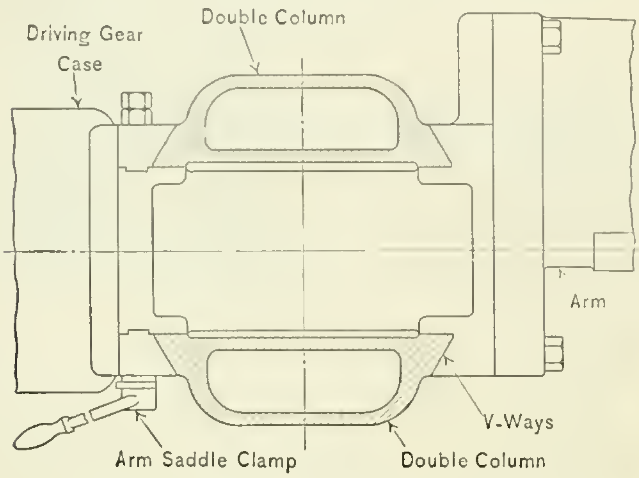


Fig. 2—Cross Section of Double Column Arrangement

vent damage or accident to the machine should the operator carelessly run the arm to the limit of its travel in either direction has been provided. This device also stops the arm in case an obstruction is met in lowering. The elevating

Fig. 3—The Main Driving Shaft Passes Between the Two Columns

screw is hung at the top of the column on a friction ring and when the spindle or arm meets an obstruction in lowering, the elevating screw is lifted and turns freely, thus stopping the arm.

Only four driving gears and one double faced pinion are used between the motor and spindle and the driving mechanism has been further simplified by eliminating friction clutches for spindle reverse and tapping operations. The spindle is quickly and accurately reversed by reversing the

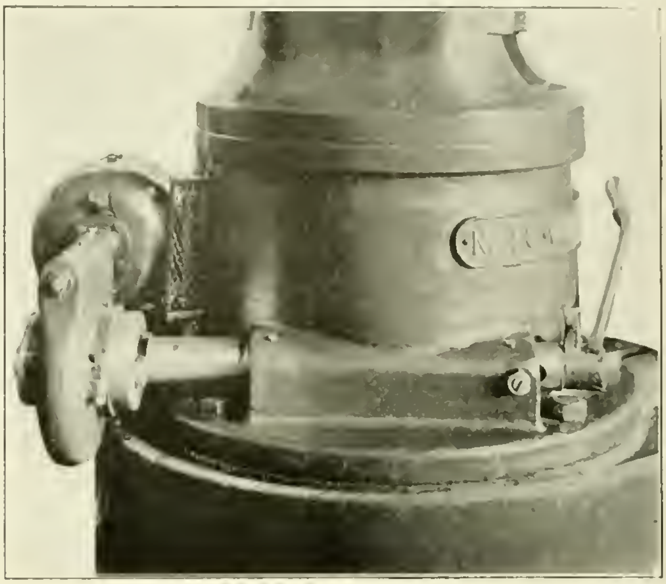


Fig. 4—View of Electric Column Clamp

motor through the controller lever. The spindle counterweight is geared to the spindle and supported at its center of gravity to eliminate friction. A depth gage with an automatic feed trip is provided for drilling to a desired depth. Rapid hand traverse of the spindle is secured by means of

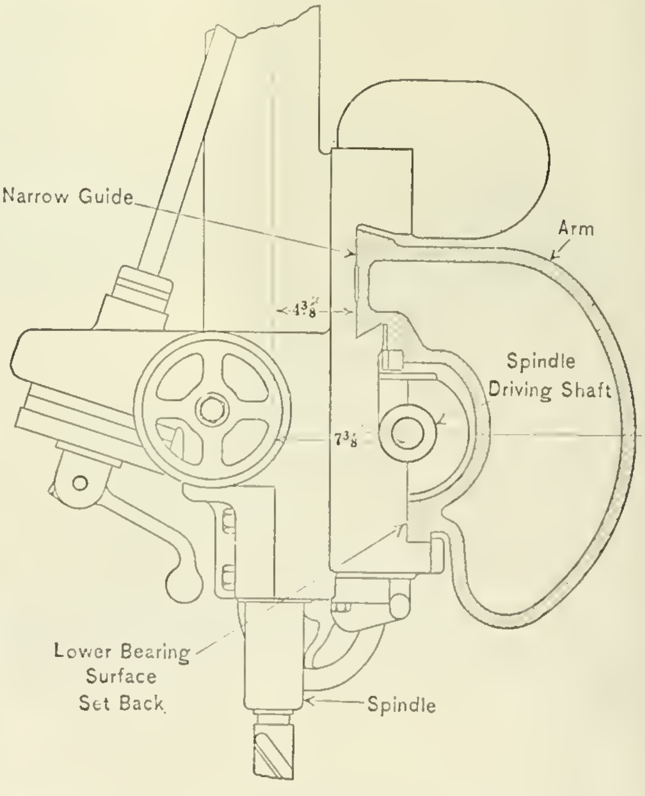


Fig. 5—Cross Section of Arm Designed for Maximum Torsional Strength

a lever which, when pulled down, engages the power feed.

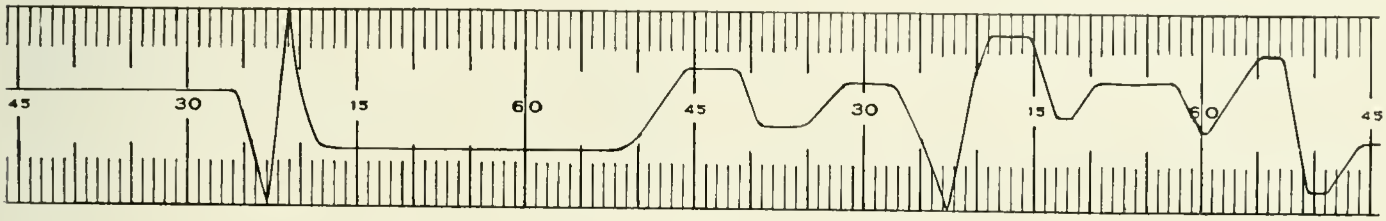
An ample range of speeds is provided and there are eight positive geared feeds changed by means of a graduated disc.

Fine hand feed for the spindle also is provided. The drill head is easily moved along the arm by means of a hand wheel conveniently located at the front of the head. On universal machines, this hand wheel can be swung back out of the way when the spindle is to be swiveled.

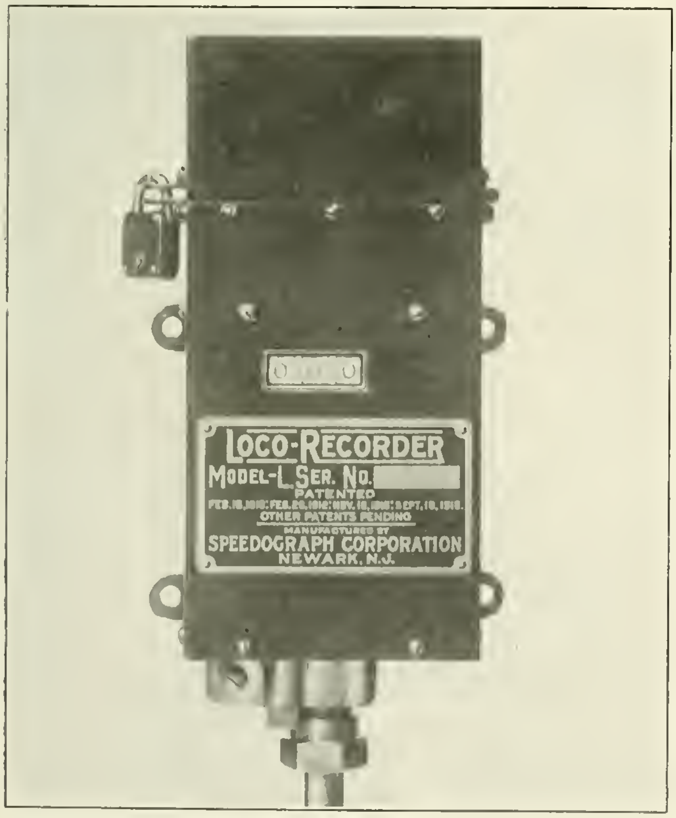
For direct current drive, a 10 hp., four to one variable speed motor is required. For alternating current drive, a gear box is included to give the additional speeds required. In either case, the motor is provided with an automatic brake for stopping quickly in tapping operations.

Recording Instruments for Switchers

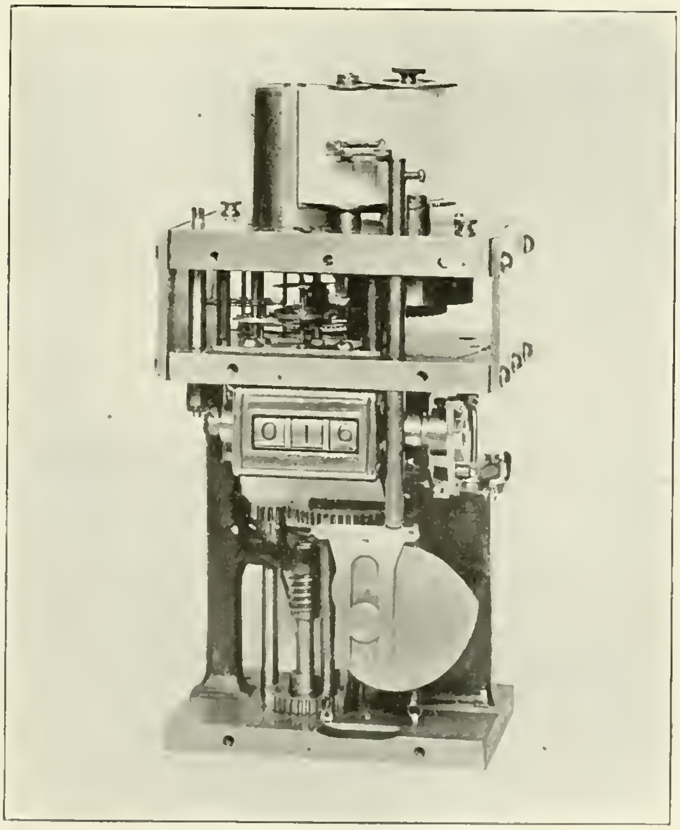
A DESCRIPTION of a model *K* recording instrument for locomotives in road service was given on page 306 of the May *Railway Mechanical Engineer* and the model *L* Loco-Recorder, described in this article, is designed for use on switchers. The instrument furnishes a clear and complete performance record of switch engines, and affords information, the vital importance of which has long been appreciated. The record shows: (1) The time in hours and minutes that the engine is idle; (2) the time in hours and minutes that the engine is working; (3) the distance in miles actually covered; (4) the speed at which the engine is operated at any point or at any time.



Record of Switchers for Four Hours Reading from Right to Left



A Locked Metallic Case Prevents Tampering With the Mechanism



Internal Mechanism of the Loco-Recorder

An odometer automatically records the exact mileage, registering every 35 ft. and can be set back to zero at the end of every day, week or month as desired. To conform to the service required of it, the recorder operates on a time basis. The recording tape, which is calibrated in minutes, is drawn past the pencil at the rate of four inches to the hour. The pencil moves up and down when the engine is in motion, the distance across the tape, 1-3/16 in. in length, representing one-half mile traveled. The angle of these lines and their relation to the minute marks show the rate of speed. Broken lines indicate reverses.

When the engine is idle the pencil remains stationary and makes a straight horizontal line on the tape. The total idle time is thus easily calculated. An actual reproduction of the record of a switch engine for four hours, is shown in the illustration. This record shows that the switcher went ahead an eighth of a mile, stood still for two minutes, reversed and ran three-eighths of a mile at a speed of nearly eight miles an hour. It then stood still for

two minutes, reversed and ran a quarter of a mile in five minutes, reversed again and ran an eighth of a mile, stood still for seven minutes, reversed again and ran 150 yards, reversed again after standing a little more than a minute and ran a quarter of a mile in two minutes and a half. After standing for four minutes the engine again reversed and ran three-quarters of a mile in eight minutes. It then made three short runs and three reverses, with three stops of about four minutes each, and was idle for 27 minutes, after which it ran a mile and an eighth at a maximum speed of half a mile in two minutes and was idle for 20 minutes. Knowledge of yard conditions makes the record a complete story of the day's work, down to the smallest detail, and it is an easy matter to compute the idle, and working time and the service performed.

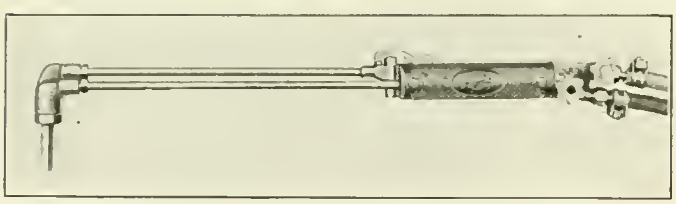
Since speed indications on a switcher are not required, the instrument can be attached to any convenient part of the locomotive and is not necessarily placed in the cab. The water-tight cover, which has to be raised for the removal and insertion of tapes, is securely locked, as shown in the illustration, and this prevents any interference with the recording mechanism. Loco-Recorders for both switchers and road locomotives are manufactured by the Speedograph Corporation, Newark, N. J.

Cutting and Welding Torch for Shop Use

CERTAIN inherent characteristics should be possessed by cutting and welding torches intended for shop service. Among these characteristics may be mentioned simplicity, ruggedness, low cost of maintenance and safety in operation. In addition, the torch should be light, well balanced and economical. With the desirability and importance of these characteristics well in mind, the A. G. A. Railway Light & Signal Company, Elizabeth, New Jersey, has recently developed a line of oxy-acetylene cutting and welding torches known as the A. G. A. torches. These torches have been thoroughly tested under severe service conditions in railway shops, navy yards and other industrial plants and are reported to have given uniformly satisfactory service.

Mixture of the gases is accomplished in the tips which are of the one piece type, thus eliminating the possibility of losing either the tip or mixer parts. The high pressure valve of the cutting torch is operated by the thumb in such a way that a single motion will open or close it. This makes alterations in pressure possible with a minimum loss of time. A welding table is furnished with the torches, and reference to the line showing thickness of metal in sixteenths of an inch, will indicate the number of tip to be used; also, the proper gas and oxygen pressures.

The standard manufacturer's torch of this make weighs only 28 ounces and is not tiresome to hold. It has been demonstrated that the effect of a heavy torch on the quality and quantity of an operator's work is most important. Not



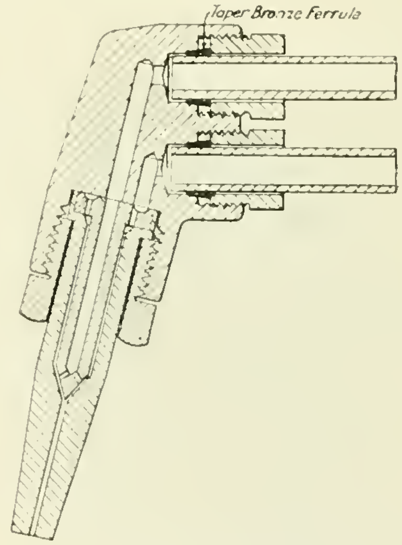
A. G. A. Cutting and Welding Torch

only is it necessary that a torch be light in weight, but it must be well balanced in order not to cause unnecessary fatigue to the operator. With hoses attached, the A. G. A. torches balance at a point in the center of the grip. The grips are made of a ventilated, non-conducting material, oval in cross section and therefore easy to control.

Gas connections are indicated by distinctive colors as advocated by the Bureau of Construction and Repair of the Navy Department, the valve handles being plainly marked "Oxygen" and "Acetylene." All inflammable gas cylinders are painted red and the oxygen cylinders, black. This color scheme being carried out in the hoses, there is little danger of wrong connections and accidental explosions.

While not intended to be abused, torches are often subjected to rough usage either through accident or carelessness. The torches, illustrated, are of rugged construction and the tips, being internally threaded, are protected against damage. The heads and valve bodies are made of drop forged bronze to insure durability, the gas head tubes being of seamless drawn brass, which is difficult to spring. Nuts on which there is a considerable amount of wear are made of phosphorous brass.

Low cost of maintenance is secured by making the torches of interchangeable parts, assembled with mechanical metal to metal joints. There are no brass, soldered or welded joints to be made. Referring to the view showing a cross



Cross Section of Torch Head

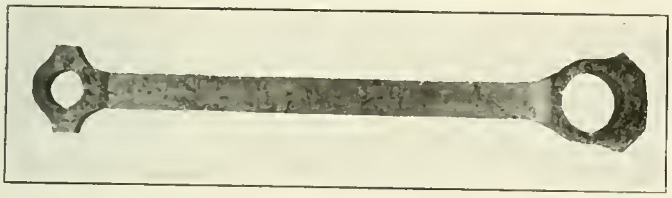
section of the torch head, it will be evident that the gas head tubes are tightened in the valve body by taper bronze ferrules forced tightly about the tubes by the hexagon head nuts. The torches can be completely disassembled by the operator and then reassembled without difficulty; hence, a damaged part does not necessitate factory repairs or scrapping.

Economy of gas consumption can be secured only by establishing and maintaining a true neutral flame. Either an oxidizing or carbonizing flame indicates an excess of free oxygen or acetylene, respectively, damaging the quality of the welds and causing uneconomical torch welds. Complete mixing is accomplished in these torches by forcing the oxygen and acetylene together at equal pressures, passing the mixture through a restricted conical orifice which sets up a turbulent effect in the stream of gas and at the same time creating a velocity which prohibits back flash. The mixed gases emerge from this orifice and proceed down the tip, the turbulent effect decreasing as the mixture becomes more

and more thorough. It is not possible to thoroughly mix gases by allowing them to run together. They must be forced together and agitated until the mixing is completed. A glance at the cross sectional view will indicate how this thorough mixing is accomplished in A. G. A. torches. Economy in gas consumption, freedom from back fire and elimination of the possibility of self-destruction, by internal burning, are secured by the design of these torches.

Facilitating the Removal of Side Rods

By making both main and side rods, also link motion rods, symmetrical above and below the true central plane, a method was described on page 105 of the February, 1917, *Railway Mechanical Engineer*, which makes it possible to get along with a much smaller stock of rods. The idea is to make the rod with two oil cups, one on each side, and by this construction, the rod can be used on either side of the locomotive, thereby reducing the number of rods required to be carried in stock by one-half.



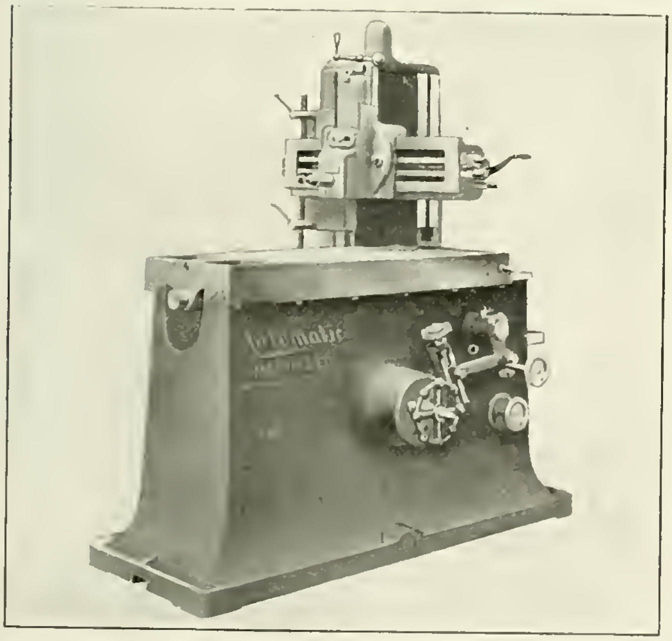
Front Side Rod With Oil Cups Set at an Angle

From the fact that only one-half as many rods as of the standard form of construction need be carried in stock, the saving in costs of material on hand is considerable. The rods can be made up and properly constructed for the same work as the standard rods, no change in counterweights of the engine being necessary.

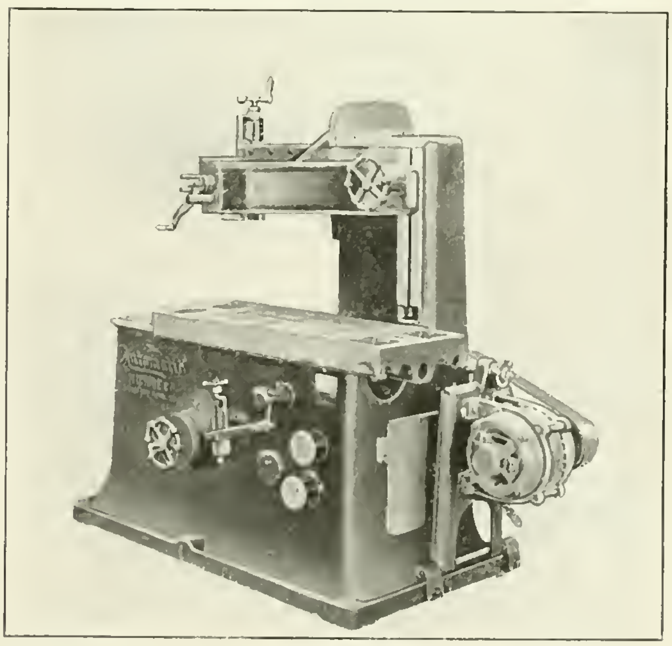
An additional feature carried out in the design of front side rods is shown in the illustration. Usually when the front section of a pair of side rods is to be removed, the engine is set with the crank pin on the bottom quarter and, in this position, the oil cup on the front side rod section extends above the bottom guide and cannot be removed without jacking up the engine. To obviate this difficulty, the side rod illustrated was designed and patented by three employees of the Delaware, Lackawanna & Western at Scranton, Pa., Charles E. Weitaw, William R. Owens and H. R. Jones. As indicated, the oil cups are set at an angle so that the upper corner of the oil cup extends only slightly above the crank pin collar. A considerable saving of effort will be effected by the use of this rod inasmuch as it can be removed easily without jacking up the engine.

Open Side Planer Proves a Flexible Unit

A machine that is equally well adapted to perform small planing operations on irregular shapes either in roundhouses or back shops, has been developed recently by the Automatic Machine Company, Bridgeport, Conn. The machine referred to is the Coulter open side planer, which has already proved its value for this kind of work.



Coulter Openside Crank Planer With 24-In. Stroke



View Showing Motor Drive and Rigid Arm Construction

Railway shop men are waking up to the advantages afforded by open side planer construction, among which is maximum ease in setting up the work, large or small pieces being held with equal facility and ample room being provided for the use of table fixtures. The clear view afforded makes it easy to adjust the cutting tool to lay-out lines on either end of the work, both ends being equally visible. Irregular shapes of a larger size than could pass between two housings are easily machined on the open side machine.

Another advantage of this particular open side planer is the fact that it bridges the gap between planer and shaper construction. The convenience and speed of the shaper is combined with the accuracy and increased capacity of the

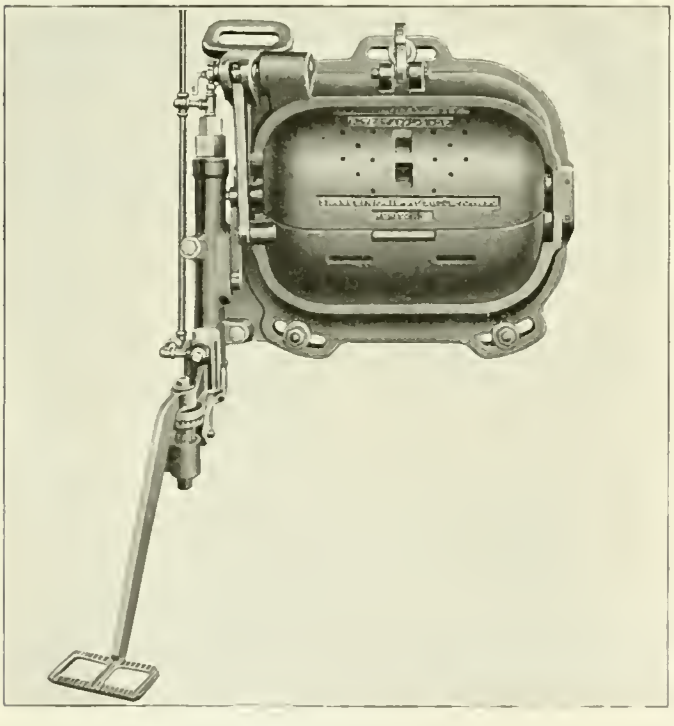
planer. Floor space is saved and ease of operation combined with high cutting speeds and feeds assures maximum output. Horizontal, vertical and angular power feed is provided, with graduated collars on the feed screw and the swivel plate. A rack and pinion raises and lowers the balanced cross rail. Sliding gears allow four speeds for each length of the table stroke.

The large supporting base forms a rigid foundation for the machine and other features tending to provide increased rigidity and accurate work are, the long, wide gibbed table provided with three tee slots and three squaring slots, the large vertical column supporting the cross rail, the length and breadth of the sliding surface on the vertical column and cross rail and the long vertical down feed slide. The bull gear, hub bearing and crank are of rugged construction and the design provides a quick return stroke to the table. Reference to the illustration showing the arrangement for motor drive indicates the compact drive arrangement. A short continuous belt gives excellent results in service, although a silent chain drive can be used if desired.

The open side counterweighted cross rail is securely held in any position by three clamps; two handles on the front are tightened by a half turn and there is a hand wheel on the rear of the arm. The design of the cross rail and braces, all in one piece, reduces the possibility of spring and provides a rugged construction.

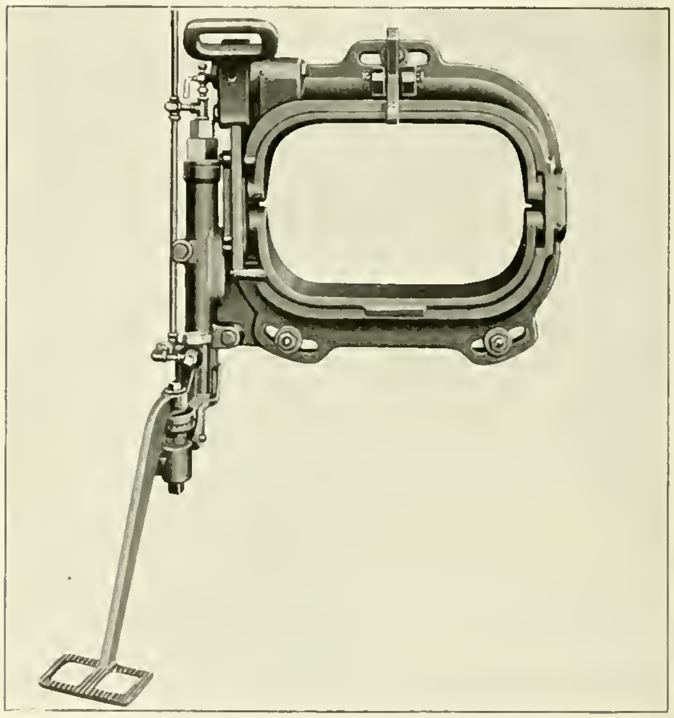
An Easily Applied Automatic Fire Door

PNEUMATICALLY operated fire doors are sometimes troublesome to apply because of the additional room required for opening. The back head of a modern locomotive has little unused space and to avoid interference with the various devices and their connections, that are necessary for efficient and safe locomotive operation, is often difficult. The Franklin No. 9 fire door was designed to permit of application where space is limited. It takes approximately the same space as an ordinary hand operated swing door and can be applied without relocating other boiler accessories. It is simple in construction and has few wearing parts. It consists of a door frame, semi-rotating door plates and operating cylinder with a foot pedal to provide power operation, and a hand grip for manual operation. A latch is provided to hold the door open in three different positions; wide open and two smoke notch positions. Air pressure both opens and closes the door; therefore it is positive in its movements. The movement of the upper door plate is actuated by the power cylinder, the motion being transmitted to the lower door plate by links. In opening, the door plates telescope inside the door frame providing full unobstructed opening for firing. This telescopic action forms the opening without taking space on the backhead outside of the door frame. The door plates rotate on pin bearings on either side.



Franklin No. 9 Automatic Fire Door Closed

In operation, pressure on the pedal admits air to the operating cylinder and the piston moves upward, transmitting motion to the upper door to rotate it around its pivots. This door is connected by a link to the rocker at the top of the frame, which in turn is connected by a link to the lower door so that the movement of the upper plate is transmitted to the lower plate to rotate it on pivots to the open position. At the top of the cylinder a small poppet valve is opened by the upward movement of the piston; this admits air to the cylinder and cushions the upward stroke of the piston at the same time the links are assuming a position which reduces the leverage on the doors and brings them to the full open position without slam or shock.



Automatic Fire Door In Full Open Position

When pressure is removed from the foot pedal, air is exhausted from the lower end of the cylinder and the air in the upper end forces the piston downward and starts the doors toward the closed position. After the piston has traveled about one-third of its movement the valve in the top of the cylinder seats, cutting off the air supply entirely. At this time the top door has traveled to a point where its weight is effective to raise the lower door. This, with the trapped air in the top of the cylinder, brings the doors to the closed position. As the piston travels downward the lower end of the cylinder acts as a dash pot and prevents slamming.

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WE GUARANTEE, that of this issue 10,100 copies were printed; that of these 10,100 copies, 9,420 were mailed to regular paid subscribers, 9 were provided for counter and news company sales, 256 were mailed to advertisers, 32 were mailed to employees and correspondents, and 383 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 84,050, an average of 12,007 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The Times Trade Supplement (London) is authority for the statement that owing to the shortage of raw materials, Belgian manufacturers have been obliged to refuse large orders for railway material, locomotives and wagons needed for South America.

A seat for a brakeman is being provided on freight locomotives in Canada, all engines to be equipped by May 1, 1921. This action has been taken on the recommendation of the Railway Association of Canada, following a request from the brakemen's brotherhood.

The Bureau of Valuation of the Interstate Commerce Commission held an informal meeting with representatives of carriers at Chicago on April 29 and 30. Engineers from roads in all sections of the country were present to discuss the progress made by the bureau in the preparation of valuation reports.

After a spirited debate resolutions were adopted in favor of government ownership of the railroads at the annual convention of the American Federation of Labor at Montreal, Que., on June 17, by a vote of 578 delegates, representing 29,159 votes in favor of the resolution and 8,349 against it. During the debate President Gompers took the floor against the passing of the resolution.

It was stated in the last report of the Indian Railways that 112 locomotives were burning oil fuel. It is anticipated that, owing to the increased output of oil from the Persian concessions of the Anglo-Persian Oil Company, the use of oil fuel on the railways of Western India will in the near future be extended. Tests conducted on this system on 20 engines fitted with different types of burners showed that the work done by one ton of oil would require 1.8 tons of coal.

Four French railroads announce that they will dismiss the men from their large shops and will have car and locomotive repairs done by contract. This is the gist of a cable despatch of May 17. The four roads are the State, the Orleans, the Paris, Lyons & Mediterranean and the Southern. The reason given for this action is that the shops were hotbeds of radicalism and their output was low. Ten thousand men will be released. Repairs will be done by private corporations able to discharge unwilling workers. The railroads are restricted by law in dealing with their employees.

The Order of Railroad Station Agents, at its biennial convention recently held at Pittsburgh, Pa., voted, after discussions lasting three days, to eliminate the word "strike" from its constitution. This action was taken because of the organization's faith in the provisions of the Transportation Act for the handling of employees' grievances. The organization also voted to remove its headquarters from Boston, Mass., to Chicago. So far as can be ascertained at the present time, this is the first organization of the kind, composed of railroad employees, which has, because of this faith, eliminated strike clauses from its constitution.

Pupils of John Marshall high school machine shop classes (Richmond, Va.), under the supervision of their instructors, built a 22-in. modern engine lathe during shop classes in exactly seven months and three days from the time it was started and the machine is now in operation in the school machine shop, where it will become a permanent addition to the present equipment. Every detail of the machine was designed, drawn and constructed by the pupils themselves. It is valued at $1,800, is 7 ft. 6 in. in length and weighs about 2,500 lb. It will swing a piece of work 22¼ in. in diameter and is 46 in. between centers. It has cross and longitudinal feeds, adjustable compound rest, and is capable of cutting screw threads from one to 52 threads per inch. The construction of the machine involved nearly every principle that should be taught in modern machine shop practice, according to the instructors of the class.

Wage Award Announcement Set for July 20

The United States Railroad Labor Board issued a statement on June 25, through its chairman, Judge R. M. Barton, to the effect that a decision on the billion dollar wage demands of organized railway employees, which the board has had under consideration since April 20, will be announced on or possibly before July 20. The public hearings on these demands terminated on June 2 and since that time the Labor Board has been in executive session.

Inspection of Freight Equipment

In the March issue of the *Railway Mechanical Engineer* on page 150, the location of the brake shaft on drop end low side gondolas, drop and high side gondolas, tank cars and caboose cars without platforms, was given as on the end of

the car to the left of the center and not more than 22 in. from the center. This is an error, as the safety appliance act requires the brake staff to be located on the end of the car to the left of the center, but does not specify any limiting dimension.

A. S. M. E. Railroad Section

In accordance with certain changes in the organization of the American Society of Mechanical Engineers, allowing for the formation of professional sections, a Railroad Section has recently been organized. The following officers have been elected: Chairman, Edwin B. Katte, chief engineer electric traction, New York Central; vice-chairman, George W. Rink, assistant superintendent of motive power, Central Railroad of New Jersey; other members of the executive committee, C. W. Huntington, president, Virginian Railway; Harry B. Oatley, Locomotive Superheater Company, and W. H. Winterrowd, chief mechanical engineer, Canadian Pacific Railway. It is understood that the Railroad Section will arrange for a special part in the program at the annual meeting of the society in New York next December.

Cost of Running a Railroad One Day

The second step in the reclamation campaign which has been instituted on the Chicago, Milwaukee & St. Paul, as noted in the *Railway Mechanical Engineer* for April, page 247, has been taken, in the form of a poster showing the daily expenditures on the road for fuel, lumber, etc. According to the poster, which is printed in brilliant red, 36 cents is paid for materials and supplies out of every dollar received by the company. It is also stated that every 24 hours the road spends:

$45,800	for fuel for locomotives.	$1,620	for station supplies.
13,700	for lumber and timber.	1,510	for shop machinery and tools.
10,200	for enginehouse expense.	1,320	for lubricants and supplies for locomotives.
8,660	for train supplies.	300	for electric light bulbs.
8,400	for ties.		
1,750	for stationery and printing.		

The committee asks for the co-operation of the employees to increase efficiency, save material and prevent waste in order to reduce the costs noted in the above items.

Changes in Rules of Interchange

V. R. Hawthorne, secretary, American Railroad Association, Section III, announces that rule 3, section k, of the rules of interchange, 1919, has been modified to read "No car will be accepted in interchange unless properly equipped with United States safety appliances, or United States safety appliances, standard, except cars moving home on car service orders, for equipping with safety appliances. Cars will not be accepted from owner at any time unless equipped with United States safety appliances or United States safety appliances, standard."

Also that rule 3, section o, is modified to read "Cars built after November 1, 1920, will not be accepted in interchange unless equipped with 6-in. by 8-in. shank A.R.A. standard type D couplers."

Working Conditions in the Prussian State Railroad Repair Shops

The Charlottenburger Neue Zeit gives some interesting facts and figures about the working conditions in the repair shops of the former Prussian State Railroad. In consequence of the demobilizing act the number of working men employed by the repair shops was increased from 70,000 to 160,000. Notwithstanding this great increase the shops are unable to meet the demands made upon them. The decrease of efficiency of the repair shops is one of the most serious problems facing the railroad management. The fact that efficiency has gone down although the railroad management spent 447,000,000 marks in 1918, and 110,000,000 marks in 1919, for the improvement of equipment, and although the materials needed, especially copper, have been delivered in the meantime in sufficient quantities, tends to show the serious aspect the situation has taken. In the summer of 1919, the repair shops turned out 750 repaired locomotives monthly. In November, 1919, only 650 were repaired and in January, 1920, only 520 locomotives were repaired.

A. I. E. E. and A. S. M. E. to Combine Forces

Plans have been made for holding a series of joint meetings of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. The object of the joint meetings is to secure a strong program and, as the war interrupted interest in normal engineering progress, to create a new interest in old problems which now require revised consideration under existing conditions. In general the subjects selected for these meetings will come under the following classifications: Marine engineering, engineering education, industrial installations, power generation, steam railroad electrification and industrial relations. It is intended to hold the first meeting in October, on a date to be announced later.

Railway Rolling Stock for New Zealand Government

The New Zealand Government has announced, writes Consul General Alfred A. Winslow from Auckland on April 10, as noted in Commerce Reports, that the railway department will expend about $8,516,375 for the purchase of rolling stock for government railroads of this Dominion, covering 65 locomotives, 35 passenger cars, 12 brake vans, and 4,092 freight cars.

It is announced that the government proposes to invite tenders in England for the manufacture of 25 large locomotives and 2,500 freight cars; and tenders in New Zealand for the building of 1,000 freight cars to be delivered in the shortest possible time.

In addition to the above the department is providing for the building of 20 locomotives, 35 passenger cars, 12 brake vans, and 592 freight cars in its own shops at the different centers. Twenty locomotives are now being built under contract by A. & G. Price, all to be delivered within five years.

Rolling stock is greatly needed, since the government railroads are not able to meet the increasing amount of freight offered for transportation, and the accumulation of all classes of traffic throughout the Dominion is very great.

It would seem, adds Mr. Winslow, that it would pay American interests to investigate this opening, for it is not probable that British manufacturers will be able to deliver these locomotives and cars in time to relieve the freight situation within a reasonable time, and rolling stock allotted for construction in this dominion cannot be supplied within the next four or five years unless labor conditions change very materially. In any event much of the material to be used in the construction of this rolling stock in New Zealand must come from outside and will call for hardware, car-building accessories, and certain lines of timber.

Interested parties should correspond with the Minister of Railways covering the general contracts, and with A. & G. Price at Thames or Auckland relative to supplies for the 20 locomotives they are building.

MEETINGS AND CONVENTIONS

Traveling Engineers' Association.—The next convention of the Traveling Engineers' Association will be held in Chicago, commencing September 14, 1920.

Master Car and Locomotive Painters' Association.—This association will hold its next convention on September 14 to 16, inclusive, at the New American House, Hanover street, Boston, Mass.

American Railway Tool Foremen's Association.—The next convention of this association will be held at the Hotel Sherman, Chicago, on September 1 to 3, 1920, inclusive.

Master Blacksmiths' Association.—The International Railway Master Blacksmiths' Association will hold its next annual convention at the Hotel Statler, Detroit, Mich., on August 17, 18 and 19. The secretary of the association is A. L. Woodworth, Lima, Ohio. The president of the supply Men's Organization is H. D. Kelley, 1427 Western avenue, N. S., Pittsburgh, Pa.

American Gear Manufacturers' Association.—At a meeting of the executive committee on May 1, held at the close of the convention of this association, the following officers were elected: F. W. Sinram, president; H. E. Eberhardt, vice-president, and Frank D. Hamlin, secretary and treasurer. Messrs. Sinram and Hamlin have served as president and secretary, respectively, since the organization of the American Gear Manufacturers' Association three years ago, during which time it has grown from eight to eighty member companies. One of the chief features of the convention was the discussion of standardization as it affects the gear industry, an entire day being devoted to this subject.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Association, Section VI. Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. B. Baker, Terminal Railroad, St. Louis, Mo.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention September 1-3, Hotel Sherman, Chicago.

American Society for Testing Materials.— C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meetings second Tuesday in month, except June, July and August.

Car Foremen's Association of Chicago.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Friday in January, March, May and September and second Thursday in November, Hotel Statler, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, B. & O., Lima, O. Convention August 17-19, Hotel Statler, Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention Sept. 7-10, 1920, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B & M., Reading, Mass. Convention September 14-16, New American House, Boston, Mass.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meetings second Tuesday in month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Meetings third Friday in month, except June, July and August, 29 W. 39th St., New York.

Niagara Frontier Car Mens' Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y. Convention September 14, Chicago.

Western Railway Club.—J. M. Byrne, 916 West 78th St., Chicago. Meetings third Monday in month, except June, July and August.

PERSONAL MENTION

GENERAL

G. L. Lambeth, superintendent of motive power and car equipment, of the Mobile & Ohio, has moved his headquarters from Mobile, Ala., to St. Louis, Mo.

G. C. Nichols, superintendent of motor power and equipment of the Alabama, Tennessee & Northern, with headquarters at York, Ala., has been promoted to superintendent, with the same headquarters, and his authority has been extended over the maintenance of way and transportation departments.

John C. Davidson has been appointed engineer of electric traction of the Norfolk & Western, with office at Bluefield, W. Va. Mr. Davidson's early experience in railroad work was obtained in Scotland where he completed his apprenticeship in the locomotive department of the Great North of Scotland Railway. After completing his apprenticeship he was employed in the drafting room and on material inspection and testing. From 1902 to 1906 he was employed by the British Westinghouse Company as assistant engineer on design of rolling stock and electrical equipment for the Mersey Railway and the Metropolitan Railway electrifications. Mr. Davidson then took up work in the United States and was employed for four years as assistant engineer by the Pennsylvania Tunnel & Terminal Railroad. In this connection he worked on the electrification of the New York tunnels, specializing in the development of locomotive equipment. He entered the employ of Gibbs & Hill, consulting engineers when the firm was organized. Here he was employed as engineer on projects and designs, appraisals and reports for heavy main line electrification and was engineer in charge of the Norfolk & Western electrification. He resigned from this work to accept his present position.

J. C. Davidson

G. G. Yeomans, general purchasing agent of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., has been appointed special assistant to the president, handling all matters assigned relating to materials and supplies.

C. B. Young, manager of the Test Section of the United States Railroad Administration, has been reappointed mechanical engineer on the Chicago, Burlington & Quincy, with headquarters at Chicago.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Edward G. Bowie, who has been appointed division master mechanic of the Brownville division of the Canadian Pacific, with headquarters at Brownville, Me., as announced in last month's issue, was born on August 20, 1892, at Winnipeg, Man. He was educated in Aberdeen High School

and began railroad work in May, 1907, as a machinist apprentice, after which he worked as a machinist until July, 1915. He was then a dynamometer car operator on the Eastern lines until October, 1915, assistant locomotive foreman and locomotive foreman until June, 1918, being located respectively at Outremont, Que., Sherbrooke, Que., and Smith's Falls, Ont. From June, 1918, to April, 1920, he was general foreman in charge of the Canadian Pacific shops at McAdam, N. B., and on the latter date received his appointment as division master mechanic at Brownville, Me.

James Davis has been appointed road foreman of engines on the Southern Pacific, with headquarters at Sparks, Nev., succeeding S. A. Canady, who has been assigned to other duties.

Charles W. McGuirk, assistant master mechanic of the Delaware, Lackawanna & Western at Scranton, Pa., has been appointed master mechanic of the Delaware & Hudson at Carbondale, Pa., effective July 1. Mr. McGuirk was born in Norfolk, Conn., on June 3, 1872, and was educated in St. John's School, Schenectady, N. Y. He served a four-year machinist apprenticeship at the Oneonta shops of the Delaware & Hudson. Subsequently he was employed as enginehouse and shop foreman on the New York, Ontario & Western, the Lehigh Valley and the Boston & Maine. In 1906 he accepted a position as foreman of the new enginehouse of the Delaware & Hudson at Oneonta, N. Y., and was promoted to general foreman of the locomotive and car departments in 1908, remaining with the latter road until April, 1912. At that time he went to the Delaware, Lackawanna & Western as general roundhouse foreman at Scranton, Pa., and about four years ago was promoted to the position of assistant master mechanic.

H. W. Sasser has been appointed superintendent of shops of the Erie at Galion, Ohio, succeeding A. J. Davis, transferred.

CAR DEPARTMENT

J. A. Deppe, assistant master car builder of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has been appointed supervisor of the freight car department, with the same headquarters, succeeding C. G. Juneau.

C. G. Juneau has been appointed acting master car builder of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding L. K. Sillcox. Mr. Juneau was born on December 12, 1874, at Milwaukee and received a public school education. He served a blacksmith apprenticeship in the car and locomotive departments of the Chicago, Milwaukee & St. Paul, which he completed on October 1, 1899, after which he was employed for about a year as a tool dresser by the Strobel Structure Company, Chicago, returning to the Chicago, Milwaukee & St. Paul on July 21, 1900, working in the car department. On February 12, 1906, he was appointed assistant foreman of the blacksmith shop. On March 1, 1918, he was appointed general foreman of the car blacksmith department for the entire system and on June 1, 1918, was made general supervisor of the freight car department, including the blacksmith department. In March, 1920, he was placed in charge of the Milwaukee terminal and shop district and on June 1, 1920, received his recent appointment.

Henry Marsh, formerly passenger car foreman of the Chicago & North Western, with headquarters at Chicago, has been appointed district master car builder of the same road, with office at Winona, Minn.

A. S. Sternberg, general foreman of the Belt Railroad of Chicago, with headquarters at Chicago, Ill., has been made master car builder, the position of general foreman being abolished.

C. L. Walker has been appointed master car repairer at the Los Angeles, Cal., general shops of the Southern Pacific.

SHOP AND ENGINEHOUSE

Harry G. Becker, who was recently appointed shop superintendent of the Delaware & Hudson at Colonie, N. Y., as announced in the June issue, has been engaged in railroad work since 1901, at which time he entered the employ of the Chicago, Burlington & Quincy at Beardstown, Ill., as a machinist apprentice. He remained with that road as a machinist and draftsman until 1909, when he accepted a position as shop demonstrator at the Sayre shops of the Lehigh Valley. He was later machine foreman and general erecting foreman until 1915, when he left the service of that road to accept the position of general foreman of the Delaware & Hudson at Colonie, New York, which he held until his recent promotion to the position of shop superintendent.

PURCHASING AND STOREKEEPING

L. J. Ahlering, traveling storekeeper on the Chicago & Eastern Illinois, with headquarters at Danville, Ill., has been promoted to general storekeeper, with the same headquarters, succeeding W. T. Bissell, who has resigned.

R. B. Bannerman has been appointed storekeeper on the Chicago division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Fond du Lac, Wis.

H. S. Burr, superintendent of stores of the Erie Railroad at Meadville, Pa., has been appointed general superintendent of stores, with headquarters in New York.

E. A. Ernst, chief clerk in the office of the district storekeeper of the Chicago, Rock Island & Pacific at Horton, Kan., has been promoted to district storekeeper at Shawnee, Okla., succeeding E. W. Morris, deceased.

W. L. Hunker, district storekeeper of the Chicago, Rock Island & Pacific, at Chicago, has been transferred to Silvis, Ill., succeeding J. C. Kirk.

J. C. Kirk, district storekeeper on the Chicago, Rock Island & Pacific, with headquarters at Silvis, Ill., has been promoted to assistant general storekeeper, with the same headquarters.

J. B. Noyes has been appointed storekeeper on the Soo division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn.

N. M. Rice, vice-president of the Pierce Oil Corporation, St. Louis, Mo., has been appointed general purchasing agent of the New York, New Haven & Hartford, succeeding G. G. Yeomans.

J. H. Sweeney, storekeeper for the Erie at Meadville, Pa., has been appointed superintendent of stores at Meadville, succeeding H. S. Burr.

E. L. Zink, chief clerk in the office of the district storekeeper of the Chicago, Rock Island & Pacific at Silvis, Ill., has been promoted to district storekeeper, at Chicago.

OBITUARY

George H. Hazelton, formerly division superintendent of motive power of the New York Central & Hudson River at Albany, died on June 10. Mr. Hazelton was in the service of the New York Central, or associated lines, for more than 53 years, starting on the Rome, Watertown & Ogdensburg. He was superintendent of motive power of that road when it was taken over by the New York Central, and was made division superintendent of motive power at Albany.

During recent years he has been assigned to special duties, retiring last fall, when he was 70 years of age. After his retirement, however, he was called back into the service for special work.

Colonel W. D. Mann, designer of the "boudoir sleeping car," used extensively in Europe, and formerly for a number of years in this country (on the Cincinnati, New Orleans & Texas Pacific), died at his home in Morristown, N. J., on May 17, at the age of 81 years.

Wilson Worsdell, formerly chief mechanical engineer of the North Eastern Railway of England, died recently at South Ascot, Berkshire, England, his death being reported in the Railway Gazette (London) of April 16. Mr. Worsdell was a pupil at the Altoona shops of the Pennsylvania Railroad when he was a young man and began his railway service in England on the London & North Western. He was at the head of the mechanical department of the North Eastern from 1890 to 1910. During this period he built about 1,000 locomotives and several thousand cars. He introduced high capacity freight cars. He had been president of the Association of Railway Locomotive Engineers, and for several years past had been a director of the Westinghouse Brake Company.

Frederick O. Robinson, for many years chief clerk to the superintendent of motive power of the Chesapeake & Ohio, and secretary of the Richmond Railroad Club, died on March 26, 1920, at a hospital in Richmond, Va. He had been in failing health for several years. Mr. Robinson was born in Farmington, N. H., on August 20, 1852, and began his railroad career with the Indianapolis & St. Louis in 1872, serving as telegraph operator for two years. He was later employed by the Indianapolis, Peru & Chicago for 16 years as chief clerk to the master mechanic. He served in the capacity of telegraph operator and clerk for the Wabash and as chief clerk to the general superintendent of the Lake Erie & Western. In 1892 he entered the service of the Chesapeake & Ohio as clerk to the purchasing agent, being later promoted to chief clerk of that department, in which capacity he served until 1895 when he was appointed chief motive power clerk, holding this position for 16 years under the late W. S. Morris and James F. Walsh. In 1911 he was appointed equipment clerk of the Chesapeake & Ohio, which position he filled until recently. On the organization of the Richmond Railroad Club Mr. Robinson was elected secretary-treasurer and held that office until his death.

F. O. Robinson

High wages and lessened efficiency still support high prices. There are as many workingmen in the country today as there were a year ago, or two years ago. But their output is not so great and their wages much higher. Production costs are therefore increased. Strikes, holidays, vacations and diminished output per man all add to the price of goods, and hold up the price level. Labor inefficiency and sabotage are to be found in the transportation question, affecting distribution and hindering an orderly recession of prices.—*The Wall Street Journal.*

SUPPLY TRADE NOTES

G. E. Lemmerich, railroad layout engineer for the Austin Company, Cleveland, Ohio, died on April 25, of heart failure.

A. B. Konsberg, dealer in railway equipment, has moved his offices from 226 South La Salle street, Chicago, to 40 North Dearborn street.

John Scullin, chairman of the board of the Scullin Steel Company, St. Louis, Mo., died in St. Luke's Hospital, St. Louis, on May 28, at the age of 83.

W. G. Cook, manager of the Chicago office of the Garlock Packing Company, Palmyra, N. Y., has been transferred and is now manager of its Philadelphia, Pa., office.

W. Searle Rose, district manager of W. L. Brubaker & Brothers, manufacturers of taps, dies and reamers, 50 Church street, New York, has been appointed sales manager.

F. J. Foley, general sales agent, and E. McCormick, assistant to the president of the Railway Steel Spring Company, have been elected vice-presidents of the company.

The Cleveland office of the Electric Storage Battery Company, Philadelphia, Pa., has been moved from the Citizens building to Chester avenue and East Twenty-fourth street.

The Buda Company, Harvey, Ill., recently completed the construction of an additional foundry, for casting small engine parts. The building is of iron, 160 ft. wide, with concrete foundation.

The Rich Tool Company, Chicago, announces that the Garlock-Walker Machinery Company, Ltd., with offices in Toronto, Montreal and Winnipeg, has been appointed its exclusive agent for Canada.

W. F. Myer has been appointed directing transmission engineer, industrial bearings division, of the Hyatt Roller Bearing Company, New York. Mr. Myer is in charge of the sale of Hyatt line shaft roller bearings.

The R. W. Young Manufacturing Company, electric turntable tractors, electric hoists and cranes, announces its removal from 80 East Jackson boulevard, to the Harris Trust building, 111 West Monroe street, Chicago.

A. C. Johnston, chief engineer of the Link Belt Company, Chicago, has been promoted to vice-president and resident general manager of the Chicago plant, succeeding Prentiss L. Coonley, who is devoting his time to other duties.

Ernest S. Jubell, in charge of materials at the plant of the Haskell & Barker Car Company, Michigan City, Ind., has been appointed general superintendent of the Union Railway Equipment Company, with headquarters at Hammond, Ind.

The George P. Ladd Company, Pittsburgh, Pa., manufacturer of water tube boilers, has opened a district sales office at 528 McCormick building, Chicago, in charge of W. M. McKinstrey, formerly district manager for the Page Boiler Company, Chicago.

The Union Railway Equipment Company, Chicago, has purchased a tract of land at Hammond, Ind., and is now erecting shops for the manufacture of its railroad freight car specialties. When completed the plant will total an investment of approximately $1,500,000.

George F. Smardon, who served as secretary and assistant to Carl R. Gray, director of operation, United States

Railroad Administration, during federal control, has become associated with the Anchor Packing Company, Philadelphia, as railway representative for eastern railroads.

B. G. Prytz has resigned as president of the SKF Industries, Inc., having been elected managing director of the parent company, with headquarters at Gothenburg, Sweden. F. B. Kirkbride, vice-president since the organization of the company, was elected president to succeed Mr. Prytz.

The Electric Controller & Manufacturing Company, Cleveland, Ohio, has opened a branch office in Boston, Mass., at 49 Federal street. The new office is in charge of M. D. Goodman. An office has also been opened in St. Louis, Mo., at 208 North Broadway, in charge of R. J. Ehrhart.

The Rome Iron Mills, Inc., New York, manufacturer of solid and hollow locomotive staybolt and engine bolt iron, announces the appointment of A. M. Castle & Company as its western representative. The latter company has offices in the principal western cities, with warehouses at Chicago and Seattle.

The Chicago Flexible Shaft Company, Chicago, has opened an office in the Railway Exchange building, St. Louis, Mo., in order to render more efficient service and distribution in the southwest territory. The office is in charge of Otto Bersch, formerly connected with the Brown Instrument Company, and Jack Stroman.

DeWitt V. D. Reiley, vice-president of the Davis-Bournonville Company, Jersey City, N. J., has been elected president, succeeding Augustine Davis, who resigned last November. Charles B. Wortham, treasurer of the company since its organization, was elected vice-president and William G. McCune secretary and treasurer.

Whitfield P. Pressinger, first vice-president and general manager of the Chicago Pneumatic Tool Company, with headquarters in New York, died recently at the Roosevelt Hospital in New York following an operation. Mr. Pressinger was born at New York on September 27, 1871. He received a public school education and shortly after beginning work he entered the employ of the company in whose service he rose to the rank he occupied at the time of his death. Mr. Pressinger was the author of "Advances of Compressed Air," which has been translated into several languages. Besides being a member of many other clubs, he was a member of the New York Railroad Club and the American Society of Civil Engineers. He also served for nine years with Company A, Seventh Regiment.

W. P. Pressinger

J. H. Kuhns, manager of the railroad department of the Republic Rubber Company, has been elected vice-president of the Union Asbestos & Rubber Company, Chicago, which company has been appointed the western railroad sales agent for the Republic Rubber Company. His headquarters will be at 231 South Wells street, Chicago.

The Page Steel & Wire Company has removed its New York offices from 30 Church street, to the offices of the American Chain Company, with which it has been consolidated, in the Grand Central Terminal, New York. The Chicago office of the company has been moved from 29 South La Salle street to 208 South La Salle street.

William Oesterlein, president of the Oesterlein Machine Company, Cincinnati, Ohio, died at his home on May 10. Shortly after coming to Cincinnati about 50 years ago he started a machine tool shop in a small way and is reputed to have built the first milling machine in Cincinnati. He was one of the founders of the machine tool industry in that city.

Allan E. Goodhue, who was managing director of the Chicago Pneumatic Tool Company's English subsidiary, the Consolidated Pneumatic Tool Company, London, England, since May 1, 1919, also director of European sales for the Chicago Pneumatic Tool Company, New York, has been elected vice-president in charge of sales of the latter company, with headquarters at New York. Mr. Goodhue was formerly for a number of years connected with the sales department of the Midvale Steel Company and the Midvale Steel & Ordnance Company in Philadelphia, Chicago and Boston, and left that company in March, 1918, to enter the service of the United States government. He was assistant manager of the steel and raw material section, Production Division of the Emergency Fleet Corporation, until January, 1919, when he became connected with the Chicago Pneumatic Tool Company.

A. E. Goodhue

The Superior Screw & Bolt Company has opened new offices at 810 Hippodrome building, Cleveland. The company, which was recently incorporated, with a capital of $500,000, intends to manufacture a complete line of tap screws and bolts. Officers of the new corporation are: president, M. T. Jones; vice-president, M. J. Riley; secretary and treasurer, W. J. Hayes.

The Norton Company, Worcester, Mass., has opened a branch office for the grinding machine division at 324 Bulletin building, under the direction of Paul Hoffman, district manager. The establishment of this branch office will in no way affect the distribution of Norton grinding wheels; these will be handled as in the past by Powell, Clouds & Co., 602 Arch street, Philadelphia.

K-G Welding & Cutting Company, 556 West Thirty-fourth street, New York, manufacturers of welding and cutting apparatus, has opened a sales office in order to accommodate its western trade, at 12-14 East Harrison street, Chicago, where a complete line of welding and cutting apparatus will be carried. William McCarthy, who has been in charge of the railroad service department, has been appointed western sales manager.

The Greenfield Tap & Die Corporation, Greenfield, Mass., has acquired all of the common stock of the Lincoln Twist Drill Company, Taunton, Mass. This company manufactures twist drills, reamers and milling cutters. These, added to the products of the Greenfield Tap & Die Corporation, give it a complete line of small tools. Edward Blake, Jr., formerly sales manager of Wells Brothers Company, is vice-president and general manager of the Lincoln Twist Drill Company.

Due to the retirement of A. F. Stillman from active interest in the management of The Watson-Stillman Company, New York, several changes in the personnel have been made. E. A. Stillman remains as president and also has full supervision of the sales. Carl Wigtel, chief engineer, has been elected vice-president, J. D. Brocks, treasurer, and A. Parker Nevin, secretary; LeRoy T. Brown has been appointed works manager, J. W. Delano, assistant works manager, and W. H. Martin, purchasing agent.

Charles Blizard, third vice-president of the Electric Storage Battery Company, died on June 12. He was born at Stevens Point, Wis., in 1864, and was educated in the east, graduating from the Brooklyn Polytechnic Institute. In October, 1893, he became associated with the Electric Storage Battery Company and was in the service of the company a total of 27 years. He was at first manager of the New York office and in 1900 he was moved to the home office in Philadelphia in charge of sales. In April, 1906, he was made third vice-president, which position he retained until the time of his death. Mr. Blizard was an active member of the Electric Vehicle Association, serving on various committees, and he later continued his activities in the electric vehicle section of the National Electric Light Association. He was also a member of the board of governors and chairman of the finance committee of the Associated Manufacturers of Electrical Supplies.


C. Blizard

The Reed-Prentice Company, Becker Milling Machine Company and Whitcomb-Blaisdell Machine Tool Company have opened a sales office at the Grand Central Palace for handling sales in the New York territory. The office will be in charge of P. K. Dayton, formerly connected with the Niles-Bement-Pond Company and Manning, Maxwell & Moore, assisted by P. A. Dyer, formerly of the General Electric Company. A store has also been opened in Cleveland at 408 Frankfort avenue, in charge of C. A. Severin, formerly of the Cleveland Tool & Supply Company, assisted by Charles Brandhill.

Frank A. DeWolff, assistant locomotive superintendent of the Cuban Central, has joined the forces of the International Railway Supply Company, 30 Church street, New York, as its traveling representative. Mr. DeWolff was engaged in active railroad work for the past 22 years, having begun as a machinist apprentice in Mexico. He subsequently served as machinist, power house engineer, locomotive fireman, engineman and superintendent of shops. From July, 1916, to January, 1919, he was general master mechanic on the Cuban Central and from the latter date was assistant locomotive superintendent in charge of the locomotive and car departments of the same road.

The personnel of the Elvin Mechanical Stoker Company, New York, is now as follows: John B. Given, president. Albert G. Elvin, vice-president in charge of operation and treasurer; F. H. Elvin, assistant to vice-president in charge of operation; Frank H. Clark, vice-president; Frederick P. Whitaker, secretary; A. B. Fahnestock, chief engineer; H. D. Eckerson, manager of road service. The headquarters of the company are at 23 West 43rd street, New York. The Elvin stoker has been in operation on the Erie for three years and is now being tested out on the Grand Trunk. A description of this stoker and its use on the Erie was published in the *Railway Mechanical Engineer* for February, 1918, page 103.

Percy M. Brotherhood, senior vice-president of Manning, Maxwell & Moore, Inc., New York, has been appointed executive vice-president with the powers and duties attaching to the office of president, succeeding Alfred J. Babcock, president, who resigned on account of ill health. Mr. Brotherhood has been associated with the company for over 25 years and during recent years has been in charge of its machine tool business. Eugene Maxwell Moore was recently elected vice-president in charge of foreign sales. Henry D. Carlton has been elected a director of the corporation, following his recent election to the office of vice-president in charge of the brass goods sales, succeeding the late John N. Derby. Robert A. Bole, general sales manager of Pittsburgh, has also been elected a director and vice-president.

Edward M. Dart, founder of the E. M. Dart Manufacturing Company, Providence, R. I., died June 5, while at his summer home at Shawomet Beach, R. I. He was born January 19, 1835, in New London, Conn., where he received his schooling, and, after gaining mechanical experience in companies in that city, he entered the employ of Law & Kannon, Providence, R. I., manufacturers of gas piping and fixtures. In 1858 he became connected with the Providence Steam & Gas Pipe Company and later went to the Mason Machine Works, Taunton, Mass. He subsequently worked for the firm of Hudson & Wood and the Perkins Horse Shoe Company, both of Providence. In 1866 he established his own business of manufacturing pipe and fittings, which grew until in 1894 he formed the E. M. Dart Manufacturing Company.

L. Finegan, superintendent of the Mt. Clare shops of the Baltimore & Ohio, has been appointed general manager of the American Flexible Bolt Company, with headquarters at Pittsburgh and Zelienople, Pa. Mr. Finegan was born in California. He began work as a machinist apprentice in Butte, Mont. On the completion of his apprenticeship he entered the employ of the New York Central at Buffalo, and later the General Electric Company and the American Locomotive Company at Schenectady. Leaving the American Locomotive Company he went with the Delaware & Hudson as general foreman. In 1904 he became general foreman of the West Springfield shops of the Boston & Albany Railroad. In 1911 he entered the service of the Baltimore & Ohio as master mechanic at Glenwood, Pa., and was later appointed superintendent of shops at this point. In 1915 he was appointed superintendent of the Mount Clare shops.

George H. Scott, electrical engineer with the O. K. Giant Battery Company, with headquarters at Gary, Ind., has been appointed representative of the Safety Car Heating & Lighting Company, New York, in charge of the Northwestern territory, with headquarters at Chicago. Mr. Scott was born on June 6, 1880, in Pulaski county, Mo., and was educated in the State Normal School. He entered the service of the St. Louis-San Francisco at Springfield, Mo., on February 23, 1899, working in various departments of this road until 1906, when he was appointed foreman electrician with headquarters at St. Louis, Mo. In December, 1907, he was appointed traveling electrician on the Chicago, Rock Island & Pacific, with headquarters at Chicago, and was later promoted to general foreman in the electrical department. He was appointed foreman electrician with the Pullman Company at Cincinnati, Ohio, on June 1, 1910, with which company he was employed until his resignation to become electrical engineer with the O. K. Giant Battery Company.

TRADE PUBLICATIONS

Belt Fasteners.—The Crescent Belt Fastener Company, New York, has published a new handbook illustrating Crescent belt fasteners in use on many different kinds of belting and under different conditions, and giving full data regarding their use.

Expansion Joints.—The Griscom-Russell Company New York, has published bulletin No. 1010, an eight-page pamphlet containing specifications for the two types of G-R expansion joints for use on low pressure steam lines to provide for expansion and contraction of the pipe.

Bearing Alloy.—The Ajax Metal Company, Philadelphia, Pa., is distributing a small leaflet describing the composition of Ajax bull bearing alloy and its advantages as a general purpose lining metal. It is claimed to be not only cheaper than genuine and other tin-base babbitts, but to last longer and run cooler.

Car Jacks.—Bulletin No. 301, an eight-page pamphlet, is being distributed by the Duff Manufacturing Company, Pittsburgh, Pa., and gives complete information regarding Duff high speed ball bearing jacks of 50 and 35 tons capacity, designed especially for raising heavy freight and passenger cars in railway repair shops.

Heating Systems.—The Gold Car Heating & Lighting Company's modern heating and ventilating systems for railway cars are described fully in a 40-page catalogue supplement recently issued. The results of laboratory and service tests made during the past winter of the company's latest type vapor valves are also contained in the supplement.

Water Distilling Apparatus.—The Barnstead Still & Sterilizer Company, Chicago, has issued a 20-page pamphlet describing and illustrating its line of water purifiers and stills. This includes several types, for commercial use, laboratory and druggist use, as well as for garages and home drinking water supply. The stills are operated by gas, high pressure steam or electricity, as sources of heat.

Arch Tube Cleaners.—A revised catalogue of locomotive arch tube cleaners (W-4) has been issued by the Lagonda Manufacturing Company, Springfield, Ohio. The catalogue goes into the subject of arch tube cleaning and describes the different types of standard cleaners made by this company, giving a description of their general construction and usage. It also illustrates repair parts and covers briefly several other products.

Superheated Steam in Yard Engines.—Bulletin No. 10, published by the Locomotive Superheater Company, New York, presents data obtained in tests made of two engines in switching service, one using superheated steam and the other saturated. Three classes of switching work were included in the test. An indicator was used and careful readings were taken, the results showing decidedly superior performance for the superheated locomotive over that using saturated steam. Detailed information of the tests is given in the pamphlet and a comparison of the performance of both locomotives is given in tabular form.

Gasoline Locomotives.—Record No. 95, published by the Baldwin Locomotive Works, Philadelphia, Pa., deals with internal combustion locomotives, weighing from 5 to 25 tons, and adapted to work in contracting operations, plantations, quarries, switching in railroad yards, etc. Various changes and improvements have been made in these locomotives since their introduction and the general principles of construction are described and illustrated. A table shows the performance, rating and principal dimensions of the standard sizes of Baldwin gasoline locomotives.

Boiler Makers' Tools.—A new and attractive book which will interest boiler makers has just been published by J. Faessler Mfg. Company, Moberly, Mo. Its 68 pages include a recently developed line of roller expanding and flaring tools for locomotive superheater tubes, locomotive arch tubes, and stationary water tube and marine boiler tubes. Special types of expanders are included for Stirling, B. & W., and Heine boilers. These and other Faessler tools are fully described in detail and illustrated.

Machine Guard Handbook.—A handbook dealing with the subject of machine guards has been compiled for the Consolidated Expanded Metal Companies, Braddock, Pa., and is being issued by that company. It is designed for the use of managers, purchasing agents and guard makers, and contains information regarding the requirements of practical guards, how to obtain suitable guards for any purpose, specifications for letting contracts, what to guard, etc. The booklet contains 44 pages, 4 in. by 7 in., and is illustrated.

Machine Tools.—Under the title of Gisholt products the Gisholt Machine Company, Madison, Wisconsin, has issued a 24-page booklet in which are illustrated the machine tools manufactured by this company. The illustrations include turret lathes, both hand and automatically operated, vertical boring and turning mills, universal tool grinders and horizontal boring and drilling machines. Several of the illustrations show machines set up for performing specific operations. The tools for use on the turret lathes are also illustrated in detail.

Turret Lathe Practice.—A reference book on vertical turret lathe practice in railroad shops has been issued by the Bullard Machine Tool Company, Bridgeport, Conn. The book contains 43 pages, 9 in. by 11 in., and is well illustrated. Detailed illustrations and descriptions of methods of tooling pistons, packing rings, air pump cylinders and rings, cylinder heads, cross heads, rod brasses, driving boxes, eccentrics and straps, throttle boxes, crank pin washers, engine truck centers, etc., are given. The book is extremely valuable as a reference for quick, efficient methods of setting up these locomotive parts and performing necessary machine operations.

Pressed Steel Cars.—A well arranged and beautifully bound catalog has been issued by the Pressed Steel Car Company, New York. It is comprehensive and well written, containing 290 pages, 9½ in. by 11 in. Clear cut illustrations of the company's products are shown on a scale large enough to indicate details. The first two-page spread shows the company's offices and works both in Pennsylvania and Illinois, and other interesting illustrations show the welfare and educational work carried on for the employees. Beginning on page 14, the various pressed steel cars including box, caboose, coke, flat, gondola, tank cars, etc., are illustrated in detail with general dimensions of the cars and a brief description of their construction. The latter part of the catalog shows the method of handling foreign shipments and includes an interesting picture of a group of 3,000 car operators working under the direction of the Pressed Steel Car Company's erecting engineers in Vladivostok, Siberia. Descriptions and illustrations of the company's specialties such as truck and body bolsters, pressed steel and arch bar trucks, brake beams, carlines, steel storage and agitator tanks, etc., are given. The method of manufacturing chilled iron car wheels is explained and tables of decimal equivalents and conversion tables are shown in the back of the catalog.

Railway Mechanical Engineer

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The Fuel Crisis

With the status of rates established and the wage controversy settled, the fuel problem remains the one thorn in the side of the railroads that promises to harass them relentlessly throughout the coming winter. It is a grave situation when many railroads are not getting sufficient coal to meet current requirements at a time when it is customary to stock for the coming winter, and it is a serious matter when any railroad has to pay over $20 a ton for locomotive coal. It is time that every mechanical employee took a renewed interest in reducing the fuel bill and in making it possible for his railroad to operate next winter without cutting off many trains from the schedule. Fuel is the pulse of the railroad; almost every operation in the conduct of the railroad, almost every physical feature in its make-up affects directly or indirectly the size of the coal bill. Of those factors which directly affect coal consumption, the condition of the locomotive is of outstanding importance. Mechanical engineers can do many things that will help save coal. One of these is to provide a joint for the outside steam pipes where these intersect the smokebox so that this connection can be kept free from air leaks, as described in an article on this subject appearing in this issue. New locomotives should be built with joints that can be kept tight, old locomotives should be provided with such joints as fast as they go through the shop. The foreman's duty with respect to saving coal is obvious; he is expected and should be required to keep the engines under his jurisdiction in the best condition possible with the facilities at his disposal. Details count for everything in this game and of these none is more important than nozzle size. Only the strictest supervision will eliminate nozzles that are needlessly restricted for one cause or another. Engineers frequently prefer reduced nozzles to insure plenty of steam under all conditions and nozzles reduced are seldom enlarged to an economical diameter, once the cause has been removed. If the roads expect enginemen to do their bit toward saving coal, they must neglect no detail in the upkeep of the locomotive that will make for efficiency.

Do Clothes Make the Foreman?

Some years ago a superintendent of motive power strolling through an important engine terminal spoke of a certain foreman for whom he originally had a high regard. When the man first tackled the job he wore overalls and a jumper. "Now," remarked the superintendent of motive power, "I see that he has discarded the overalls," and added laconically, "When he discards the jumper I think I will have to let him go." Perhaps the superintendent of motive power knew from the way things were going that the foreman was losing his grip on the job and accepted his habit of dress merely as an indication. On the other hand, would the superintendent of motive power have been justified in accepting this incident as proof that the foreman was not making good? It has been alleged that some well-known corporation magnates would judge a man by the clothes he wore. If the young business man must wear good clothes to make an impression and get ahead in the world, must the railroad foreman wear old clothes or a suit of overalls to "stand in" with the superintendent of motive power? It is well enough to say that the matter of dress is at best a superficial question, but many men take the subject quite seriously. These men feel that their character of dress will not only make an impression on their superiors, but will affect the relationship with the men under their supervision.

The man who wears overalls or his oldest and most grease-

stained suit in order to make an impression on the superintendent is no more deserving of criticism than the man who believes that a silk shirt and neatly creased trousers will command greater respect from the men who are obliged to go about in dirty overalls. The railroad shop or roundhouse is no place to display your particular preference for green or red neckwear, plain or striped hose, and so on; nor is it the foreman's place to banish modest self-respect and grovel in dingy garb in order to make it appear that he has just emerged from the inspection pit when, as a matter of fact, he has been comfortably lounging in the foreman's office. It is suggested that in view of the present high cost of living the shop is a good place to wear out the suit that your wife objects to having you wear downtown. It is further suggested that a moderate display of white linen sets well on any foreman, not so much as a matter of personal taste or even self-respect, but as an indication of the fact that you have your work well organized, that you do not find it necessary to personally inspect every bolt and rivet—in fact, that you are using your head as well as your arms and legs.

No Cause for Complaint

The railroad labor organizations profess to be dissatisfied with the award of the Labor Board which granted an increase of 13 cents an hour to the shop crafts. The principal argument advanced by the unions to support their claims for higher wage scales was the advance in the cost of living. It is therefore interesting to analyze the award from that viewpoint. The cost of living at present is variously estimated to be 100 to 115 per cent higher than in 1914. The statistics of the Interstate Commerce Commission for that year are incomplete, but they show that the average daily compensation of machinists in railroad service was $3.27 and of carpenters $2.66. The present rates for an eight-hour day are $6.80 for machinists and $6.48 for car men, making the increases 108 per cent and 144 per cent, respectively. However, in 1914 many shops were working 10 hours instead of eight and all overtime is included in the wage given in the commission's report, so the actual percentage of increase is greater than shown above.

The statistics for 1915 are more complete and while they include some advances in wages over 1914, they furnish an interesting basis for comparison. The average hourly wages of mechanics in 1915 were as follows: machinists $0.386, boilermakers $0.386, blacksmiths $0.371, car inspectors $0.232, car repairers $0.265 and mechanics' helpers and apprentices $0.226. The present rates, therefore, represent increases in the hourly wage of 120 per cent for mechanics and boilermakers and slightly more for blacksmiths. Helpers now receive 174 per cent more than in 1914, while car repairers and car inspectors have had increases of 202 per cent and 245 per cent, respectively. If the numerous differentials for special service were included these increases would be still greater.

The labor organizations have contended that the employees should receive increases proportionate to the increase in the cost of living, even though the hours of work were reduced. This rule has not been applied to the compensation of other classes and cannot be put in force generally until the effects of the world war are overcome and productivity of labor is increased. The unions have demanded preferred treatment and have received it. There is no basis for the claim that justice has not been done. There are always malcontents in any organization, but the majority of the shopmen are satisfied with the new award, and if the labor organizations try to stir up discontent the roads should combat it by giving publicity to the facts of the case.

The Small Power Plant

It may be recalled that in July the *Railway Mechanical Engineer* commented editorially on the modernization of stationary power plants and referred inadvertently to an article dealing with the installation of superheaters as a means for increasing the efficiency and capacity of the small boiler plant. The article referred to, as written by the assistant engineer of an eastern railroad, appears in this issue and is well worth the attention of mechanical men who are struggling with the problem of getting sufficient power out of the small, antiquated and overloaded power plants that may be found on almost any railroad. If it were practical to add immediately to the stationary boiler plant wherever new boilers are required, the problem would be a simple one indeed. But mechanical men are confronted with the problem of getting results with the means at hand. A change in the grade of coal furnished to the power plant will sometimes work a great improvement and where two or three grades of coal are being received on the railroad it may be possible to select a character of fuel that is more suitable than that in use. Where this can be done, the co-operation of the transportation department should be solicited with a view to having this switched to the overloaded power plant, and if necessary, cars containing this particular grade of coal should be tagged for power plant use, at the junction point where received or in the freight yard where classified.

The *Railway Mechanical Engineer* hopes to publish in an early issue a description of means undertaken on a southern railway to relieve an overloaded boiler plant, where oil fuel was substituted for coal with the result that it was possible to generate sufficient steam without additional boiler equipment. While the installation of superheaters in the stationary power plant as described in this issue involves a greater initial expense than either of the expedients above referred to, the fact that it improves the efficiency as well as the capacity of the power plant should not be overlooked. In this instance the superheaters provided additional power for much less than the cost of the equivalent in new boilers. Where additional boilers would have increased coal consumption the superheaters have reduced it.

Rehabilitate the Wooden Box Cars

One of the most gratifying items in the report of the special committee of the Association of Railway Executives recommending the distribution of about $184,000,000 of the $300,000,000 loan fund created by the Transportation Act, is the proposal of loans totaling $7,062,053 to apply on addition and betterment to 12,616 cars and locomotives. This equipment, now unsuitable for economical service, can be made available for effective use for a smaller expenditure of money, labor and material than an equivalent amount of new equipment can be provided, in a much shorter time.

Of these 12,616 units, 10,675 are box cars. But this number is far short of the possibilities for rehabilitating old box cars. There are probably more than 100,000 box cars of all-wood construction still in service the greater proportion of which are fit subjects for reinforcement. These cars, with wood draft sills, inadequate draft gears and many of them with weak trucks, do not provide adequate protection to the commodities which they themselves carry and are a constant menace to the safety of train operation. They are the cause of frequent delay to train movement and their maintenance requires an amount of labor and material entirely disproportionate to the actual service they render.

Most of these cars would have been retired during the past five years had pre-war conditions been uninterrupted. But to retire more than a small percentage of them now

would cripple the resources of the railroads for the handling of grain and general merchandise. On the other hand, to continue them in service in their present condition is exceedingly wasteful. The only logical course is to rebuild and reinforce them. This can probably be done for about one-third the cost of an equivalent amount of new equipment and they will cease to be a factor in the maintenance problem for the next four or five years. An added life averaging 10 years would justify the required expenditure and the saving in maintenance during the three or four years it will be necessary to defer retirement whether they are reinforced or not, adds materially to the attractiveness of the proposition.

The material required for the betterment of these cars can be supplied to take care of more of this work than is now under way. The car departments of every road having even a small number of these cars should consider carefully the possibilities of their rehabilitation and get approval of a plan for carrying out the work. With a program once adopted, it should be carried out as fast as the cars can be put through the shops.

An Object Lesson From Abroad

English locomotives cannot be considered impressive from the standpoint of size, weight or tractive power in comparison with American locomotives, nor does there appear to be anything strikingly novel in their construction in view of the fact that British practice is certainly more conventional than our own. However, the impression one receives from the study of a new English locomotive is that the design is the result of the most thorough study and painstaking attention to detail. There is nothing hit-or-miss about the English locomotives. They are usually designed for a specialized service and meet the requirements of that service to a nicety. The best evidence of this may be found in the initial trial trips that are usually undertaken upon the completion of a new English locomotive. The fact that such tests are not customary in this country by no means proves that locomotive development is not on a very high plane here. American manufacturers have done an immense amount of research work, the results of which are at the disposal of the railroads, and American railroads as a whole have had the good judgment to follow the lead of the relatively few roads that have been in a position to do pioneer work on locomotive development. It is doubtful if the spirit of co-operation with respect to mechanical development manifested between railroads in this country is equally characteristic of other countries. However, in this country it is generally taken for granted that a new locomotive is developing the maximum tractive effort specified, that the valves are set just right and that the reverse gear does not creep, that passages between the dome and steam chest are ample and that the locomotive can develop a high degree of superheat. In other words, the locomotive is assumed to be one hundred per cent perfect for the service for which it is designed until reports from various sources, some of which are decidedly non-technical, either tend to confirm or to contradict this assumption. If the locomotive "makes good," that is usually sufficient, although this may be due to the fact that the locomotive has an unsuspected margin of capacity and does not necessarily prove that every part is functioning properly and that its performance could not be further improved by an adjustment or correction in design. The case of the locomotive that does not fulfill the requirements is different. These engines are generally tested but not always as rigidly as they should be, although sometimes the fault is located by a careful test in which the builder usually co-operates. The time will come when specifications on which locomotives are purchased will stipulate that capacity and efficiency be demonstrated under test conditions.

COMMUNICATIONS

STEAM GATHERING PIPE AS A SUBSTITUTE FOR STEAM DOME

Dallas, Tex.

To the Editor

The comments in your editorial (page 256 of the May, 1920, issue) suggest the use of a steam gathering pipe perforated on its top side and extending along the barrel for some distance. The area of the perforations should be in excess of the area through the throttle valve when fully open. This device permits the steam from a much larger volume of steam space than is possible with any steam dome. The liability of water entraining with the steam is thus reduced very considerably. The engines built in the last few years on the Great Western Railway of England have no domes at all, but use a perforated pipe, and engineers have told me that they can carry water from three to four inches higher on these engines than with boilers fitted with domes. I have also seen perforated pipes used in stationary boilers in New Zealand to prevent water being carried over to the engines and the results were quite satisfactory.

P. D. Anderson.

SHALL CRAFT UNIONS REPRESENT THE FOREMEN

New York.

To the Editor:

Early in June there was issued from the headquarters of the Federated Shop Crafts a circular regarding certain petitions for wage increases which had been presented to the Labor Board and stating that these included adjustments and improved working conditions for foremen. This circular directed that a campaign be instituted to bring all supervisors below the rank of general foreman into the craft organizations, "using every legal means toward that end." The desire for power is inherent in human nature; and as the original field of activities for craft unions had been well covered, an attempt to enlarge this field if possible was natural. The next step would be to control supervision.

The shop foreman, as a rule, has risen from the ranks of labor, has often been a union man, or friendly to organized labor. Previous to government control he too often was denied working conditions and compensation in proportion to his duties and responsibilities, his subordinates often receiving more than he did. These conditions inevitably led to the conviction in the minds of foremen that in organization lay the only means by which they could obtain a square deal and resulted in many foremen joining the craft unions.

In different sections of the country, however, supervisors were brooding over their condition, with the result that they came to the conclusion that their only salvation lay in a supervisors' organization. This gave rise to two organizations, both working toward the same end but with conflicting opinions on some points, rendering it impossible heretofore to unite the two bodies. Consequently foremen are divided into four groups, those belonging to no organization, those allied with the craft unions and the members of the two competitive bodies.

The crafts are antagonistic to the idea of a supervisors' organization for obvious reasons and a definite compaign to suppress this movement and coerce foremen into membership of the craft unions did not come unexpectedly. The question now arising is, what should be the foreman's attitude toward membership in the craft unions? The writer, a shop foreman, offers the following opinions with reasons annexed as the feeling of himself and his immediate associates:

Three elements are necessary for the effective conduct and promotion of business—capital, labor and management. Capital supplies the money to run the business, labor does the work, while the function of management is the employment of capital and the direction of labor in conducting the business. Management is the keystone in the arch of business.

The duties of the foreman are distinctly those of management. He employs, disciplines and dismisses labor directly or by recommendation. He plans and directs the operations entrusted to him. He uses capital when ordering supplies and signing time slips, virtually signing his name to a check on the treasury. He is responsible for the maintenance of the tools and property under his care and carries out the agreements with labor as to wages and working conditions. He also recommends improvements and change in policies, and guards the wellbeing of the employees under his charge.

The duties of the foreman of a half a dozen sweepers are the same on a small scale as those of the general manager; the same principles governing both. The fact that a mechanic may be as able and intelligent as his foreman does not enter into the question. Their duties, conditions of employment, and viewpoints are different and must always be so.

A letter from the Director General shortly before the return of the railroads to private control expressly stated that foremen were officers. Detailed instructions on this basis were issued as to foremen's working conditions.

The functions of a railroad are different from those of ordinary business in that the public grants special privileges, such as the right of condemnation of private property, in order that the railroad may be properly constructed and equipped for operation. These privileges are granted with the understanding that transportation so vital to the public will be maintained, making the railroad a public utility and placing its management a direct obligation to the public.

The man who accepts the position, salary and perquisites of a foreman also shares the responsibilities of the management, one of which is to maintain transportation at all times and under all conditions. While this may be true of the workman as well as of the foreman the workman is not responsible for the operation of the railroad and the foreman should not obligate himself to be guided by the wishes of any body of men who for any reason may undertake to interrupt transportation.

If the power of organized labor could be so extended as to include everyone up to the general manager and a strike of all ordered, one could scarcely imagine what the result would be. Yet this is the principle involved when the union undertake to control the "bosses."

We hear a great deal now about industrial democracy, which means giving labor a voice in the management. It is possible that at some future time this principle can be applied to railroads, but it will not relieve the management of its responsibility when, if ever, this time comes. Any attempt by a craft organization to legislate for foremen without their authority is unwarranted.

The question now arises as to how the foreman can protect himself from injury resulting from his refusal to be dominated by organized labor, and also to maintain good working conditions, just compensation and the security of his position. As organization is beneficial to capital, and as labor is endlessly proclaiming this privilege, it is but logical that management avail itself of this right. The problems of the yardmaster, roadmaster, station agent, and all those having immediate direction of labor are similar and could be handled by one association, but whether this plan is adopted or these occupations have separate organizations federated, they should be of, by, and for supervision that their problems may be handled befitting their station.

At this time, when all railroad management is working under depressing conditions, the assurance that, no matter what has happened heretofore, no supervising officer will ever again be compelled to work for less compensation than his subordinates, that his position shall be respected, and his working conditions maintained in keeping with that position, will do much to influence him to stay with the railroads, do his best and refuse to be dominated by organized labor.

Harold C. Prentice.

EDITORIAL ON WELDING BRINGS REPLY

New York.

To the Editor:

The editorial in the July issue of the *Railway Mechanical Engineer* entitled, "The Status of Autogenous Welding," points out that the railroads accepted this process as a cure-all during the early developments of the art and states there is grave danger of the re-action now going too far the other way. It is very necessary to have the work properly laid out and prepared; moreover, much depends on the skill of the operator; more than most of us realize. A careful check must be made of the welds each operator is making and the best way is to have in the supervisory forces of the road a man who devotes all his time to looking after welding. On small roads where there is hardly enough welding work done to warrant one man devoting all his time to welding work, a systematic check of welds can be made without much inconvenience on the part of the foreman in charge, by having the operators make test specimens at frequent intervals. The simple process of breaking these specimens will show if the operator is making a good weld; that is, if the metal is thoroughly united. If proper facilities are available, pulling the test specimens on a tensile machine is a much better check. A record should be kept of each check made of the operator's work and while the fact that test specimens show up well does not guarantee that other welding work will be as strong, it will go a long ways towards insuring good welds.

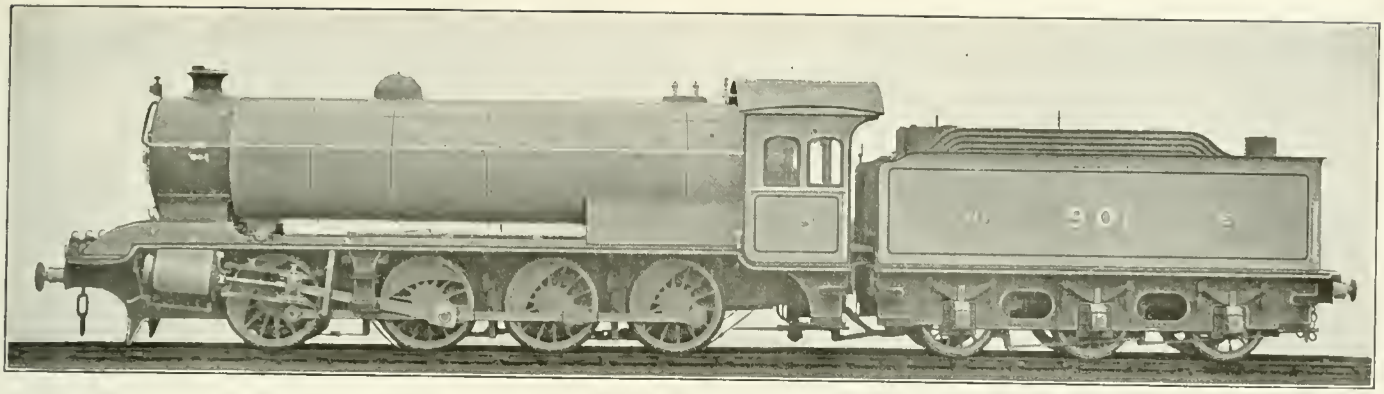
Some roads that have gone into firebox repairs by autogenous welding have been enabled to lengthen out firebox life as much as 100 per cent. Side sheet renewals are being made on boilers of types that absolutely prohibit the riveting process. Patches are being successfully welded in back flue sheets at practically all locations in the sheet. The money saving involved is so much that it will pay any road to have its supervisory forces spend sufficient time to check the operator's work. Almost any method would really be warranted that would keep the autogenous process of doing boiler work in use in preference to going back to the old methods.

One of the things that has had a lot to do with the present re-action on this subject is the over-enthusiasm that was displayed on the welding of small boiler tubes to back flue sheets. Occasional leakage of tubes is eliminated by welding but a number of roads have welded tubes in engines, particularly where water conditions are not good, with disastrous results. In bad water districts, or in localities where there is quite a scale formation on the tubes and flues immediately adjacent to the tube sheet, much trouble has been experienced with welding small tubes. The tube either develops longitudinal cracks after a few months' service or the bridges in the tube sheet crack.

That scale formation causes these troubles has not been proven conclusively, although scale deposit has a tendency to prevent the water from properly cooling the sheet. The theory is that using the prosser expander reworking unwelded flues loosens this scale so that it may be washed out.

If a locomotive will give reasonable mileage with small tubes unwelded, there is no particular point in welding them as there is grave danger of bringing about attending troubles that are much worse than occasional tube leakage. The art of electric welding is still in its infancy in spite of the fact that there have been wonderful developments made during the last few years. It certainly would be unfortunate if the re-action was to result in the railroads neglecting the art.

General Foreman.



North Eastern Mineral Hauling Locomotive

North Eastern Builds Mineral Locomotives

These Engines Typify English Designs and with a Tractive Effort of 37,000 lb. are Relatively Powerful

BY ROBERT E. THAYER

European Editor of the *Railway Mechanical Engineer*

The North Eastern railway has recently built and placed in service some of the most powerful freight engines used in Great Britain. These engines were built in the company's shops at Darlington, to the designs of Sir Vincent Raven, the chief mechanical engineer of that road. They are classified as mineral locomotives of the T.3 type having an 0-8-0 wheel arrangement. These engines are to be used in the coal traffic in the Newcastle district and are designed to haul a load of 1,400 metric tons (1,543 short tons) on a 0.5 per cent grade. They have three simple cylinders 18½ in. by 26 in. They weigh 160,380 lb. in working order, the total weight of the engine and tender being 259,200 lb. They have 55¼ in. drivers, carry a boiler pressure of 180 lb. and have a rated tractive effort of 36,960 lb.

These engines are considered powerful for English practice. They are built very nearly to the clearance limitations of the North Eastern. The width over cylinders is 8 ft. 9 in. which is 3 in. less than the minimum clearance width and the top of the stack is 13 ft. 1 in. above the rail which is 5 in. less than the minimum height clearance. The general arrangement drawing is shown in Fig 1 (page 506).

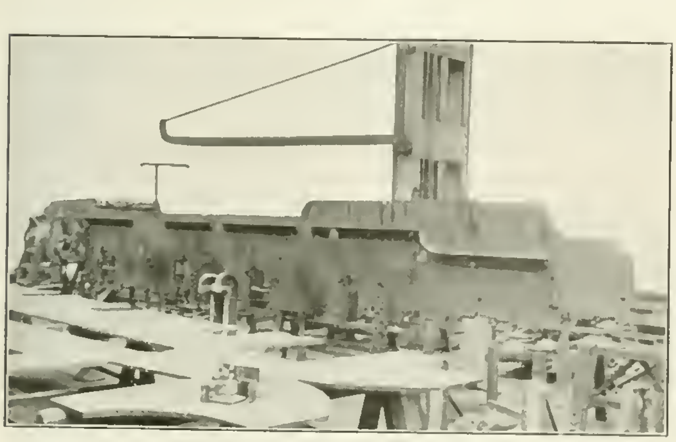


Fig. 2—Plate Frame for North Eastern Mineral Locomotives in Process of Construction

These engines were given a dynamometer test with a train consisting of a dynamometer car, 60 loaded coal cars and a brake van or caboose having a total load of 1,402 long tons. This train was tested over a 60 mile section having a ruling grade for a short distance of 0.57 per cent. The contour of the line is such that there is a steady pull to the summit of the grade. The maximum drawbar horsepower developed in these tests exceeded 1,100 d.h.p. On the test trip running in the opposite direction there is a ruling grade of 0.93 per cent for about 4 miles. The train in this direction consisted of the dynamometer car, 60 loaded freight cars and a guard's van which gave 787 long tons as the total weight of the train. During this test the train was stopped on the ruling grade and a start was made with a drawbar-pull of 28,000 lb. and the speed was increased to 16 m. p. h. in seven minutes after starting.

These locomotives are equipped with the Schmidt superheater, brick arches, steam reverse gear, force-feed lubricators to the cylinders, the Lockyer double-beat throttle valve and exhaust steam injectors.

Following is given a brief description of these locomotives together with a description of some of the practices followed in their construction.

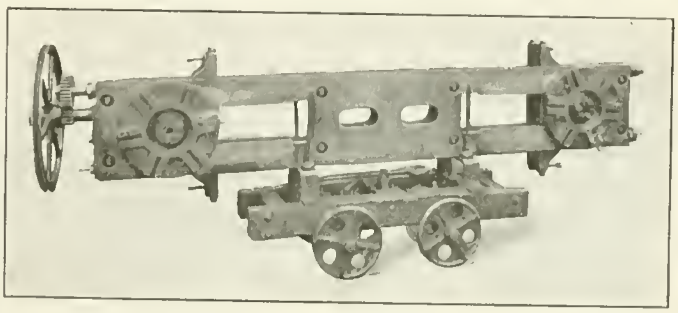


Fig. 3—Horn Facing Machine for Finishing Pedestal Jaws

Construction Details

These engines following the customary British practice are equipped with plate frames which are 1⅛ in. thick, 3 ft. 7½ in. deep between pedestals and 2 ft. 1½ in. deep over the pedestals, being spaced 4 ft. apart. These frames are shown in the process of erection in Fig. 2. No system of

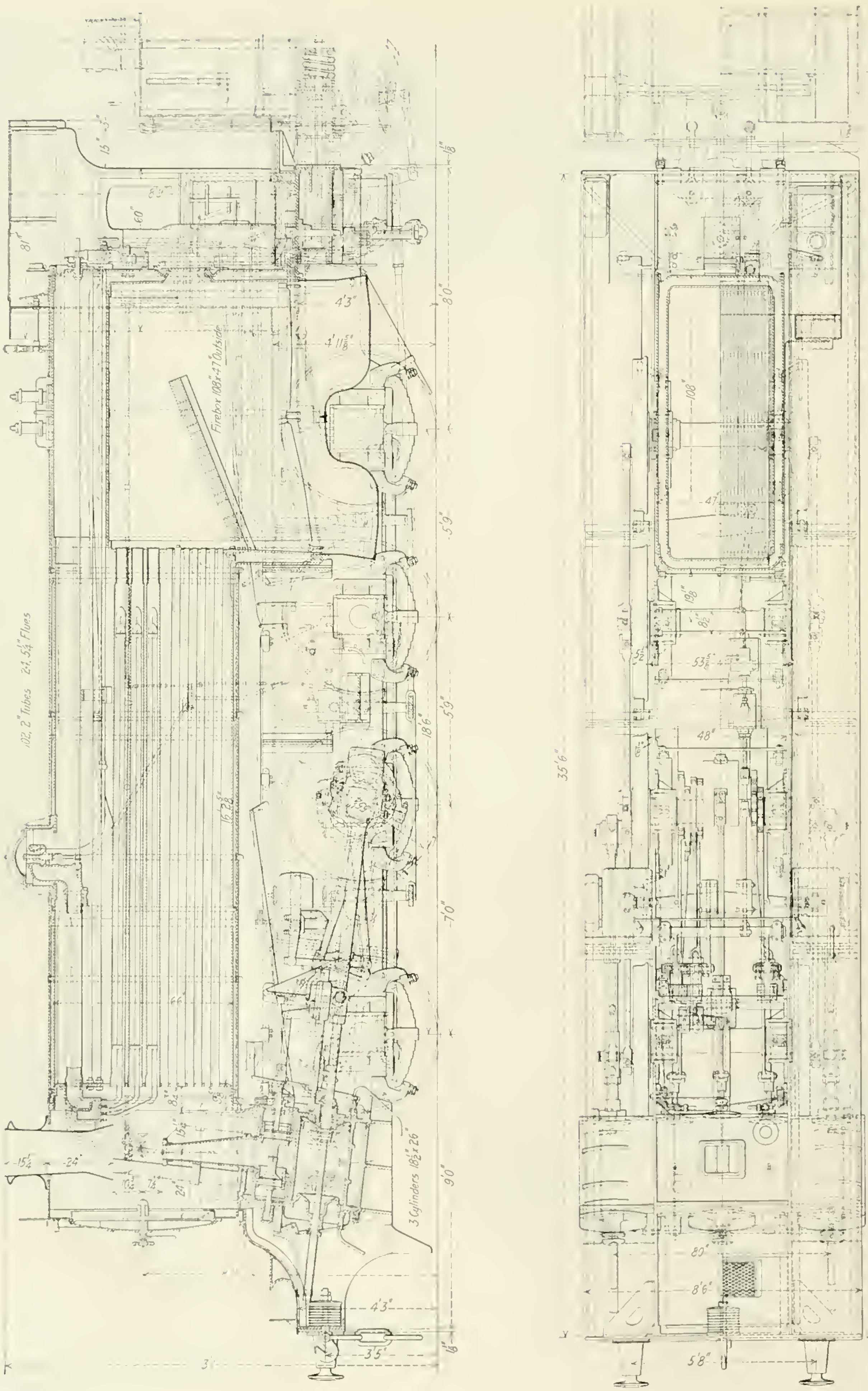


Fig. 1—General Arrangement of the North Eastern Mineral Locomotives

equalization is provided on these locomotives and the heaviest axle load is carried on the first pair of drivers which amounts to about 41,000 lb. No shoes or wedges are used on these engines as a careful machine fit is made between the driving box and the pedestals. The pedestal jaws are faced with a special device known as the horn facing machine, a picture of which is shown in Fig. 3. This is a portable device and its method of application is indicated in Fig. 4 which shows a repair engine having its pedestals refaced. With this machine an accurate surface in the pedestal jaws is obtained, the degree of accuracy being indicated by a clearance limitation of .008 in. between the driving box and the pedestal faces of the leading drivers and a clearance of 0.13 in. between the driving box and the pedestal for the axle under the firebox. An additional clearance is given to this driving box on account of its proximity to the firebox where an allowance must be made for expansion of the parts.

The driving boxes are lubricated from oil cups attached to the frames. Two lubricating pipes pass from each cup to each of the leading boxes and five to the rear driving boxes. Additional lubrication is required in this case on account of the heat to which the driving box is subjected from its proximity to the firebox. Force-feed lubrication is provided for the valves and cylinders, the force-feed lubricator being placed just above the leading axle on the frames and deriving its motion from a system of levers coupled to the inside valve rod. One interesting feature in the construction of this engine, in fact all engines built in these shops, is the fact that the cylinders, which in this particular case are all in one casting, are mounted on a dummy frame and the cross heads and other motion work are placed in proper alinement. A view of this dummy frame is shown in Fig. 5. It will be seen that there is plenty of space to get at the various parts which greatly facilitates the work.

This fitting having been carefully done these parts can be mounted directly onto the frame of the locomotive without additional adjustment. In a like manner the valve motion links are adjusted on the link truing table preparatory to their being applied to the locomotive and thus effecting a considerable saving in time.

This locomotive having three cylinders requires the cranked axle which in this particular case is of the solid type, although the built-up type is used to some extent on this road. The rods drive on the second axle and Fig. 6 shows this axle with the wheels mounted and after the eccentrics and the driving boxes applied. The cylinders which are shown in Fig. 7 are cast in one piece. They are bored on a special machine (Fig. 8) which was designed especially for three cylinder work and which permits all three cylinders, and by special attachments, the valves also, to be bored at one time. The valves used in these engines are shown in Fig. 9.

Boiler

No less care is taken in the construction of the boiler than in the construction of the rest of the locomotive. A drawing of the boiler is shown in Fig. 11. It is made up of three

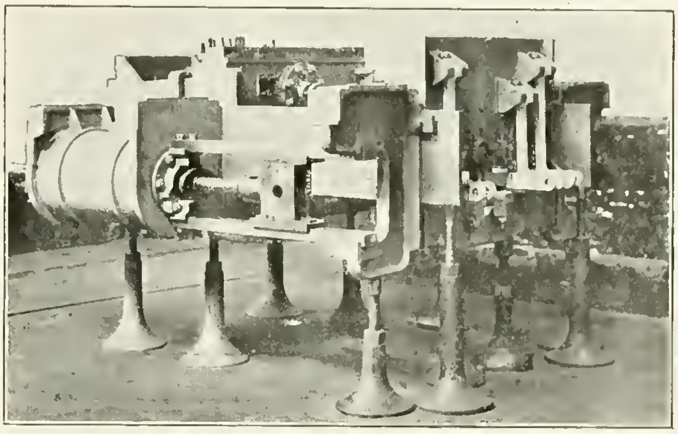


Fig. 5—Rear View of Dummy Frame

parallel rings of 66 in. outside diameter. The barrel plates are ⅝ in. thick, the front tube sheet ⅞ in. thick, the wrapper sheet ⅝ in. thick and a back head of ⅝ in. The firebox is made of copper, the roof and side sheets being made of one piece and being ⅝ in. thick. The tube sheet is 1-3/16 in. thick, being narrowed down to ⅝ in. thick at the throat

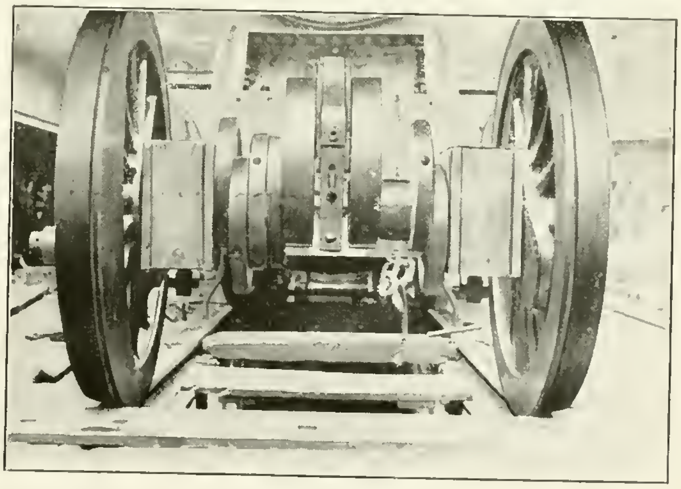


Fig. 6—Cranked Axle Ready for Application to the Locomotive

This boiler has 102, 2-in. tubes and 24, 5¼ in. superheater flues and 7 stay-tubes. The distance between tube sheets is 16 ft. 2⅝ in. Through these stay-tubes pass stay-rods of 1 in.

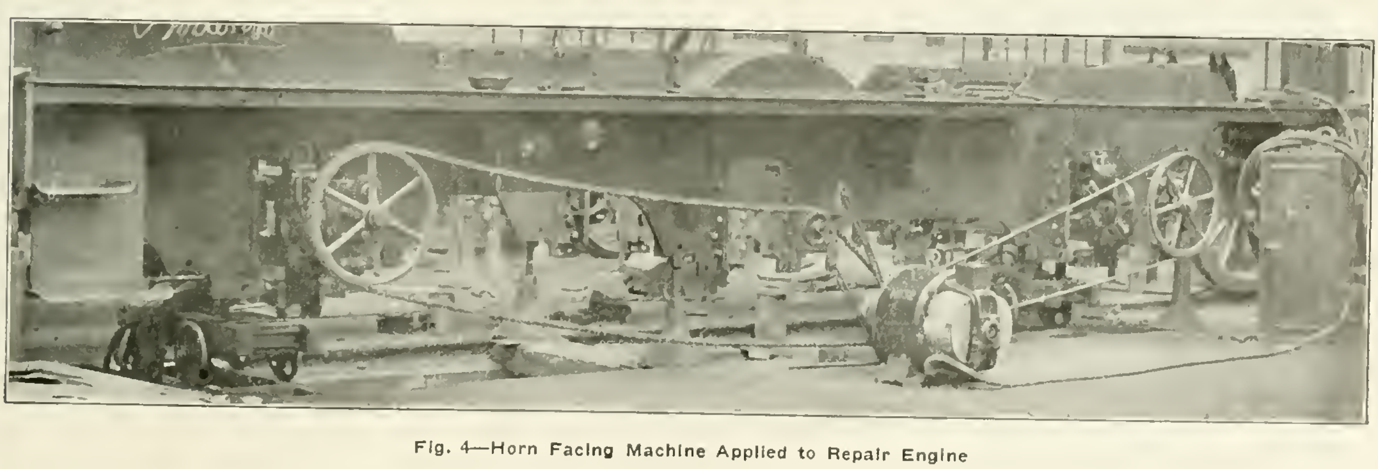


Fig. 4—Horn Facing Machine Applied to Repair Engine

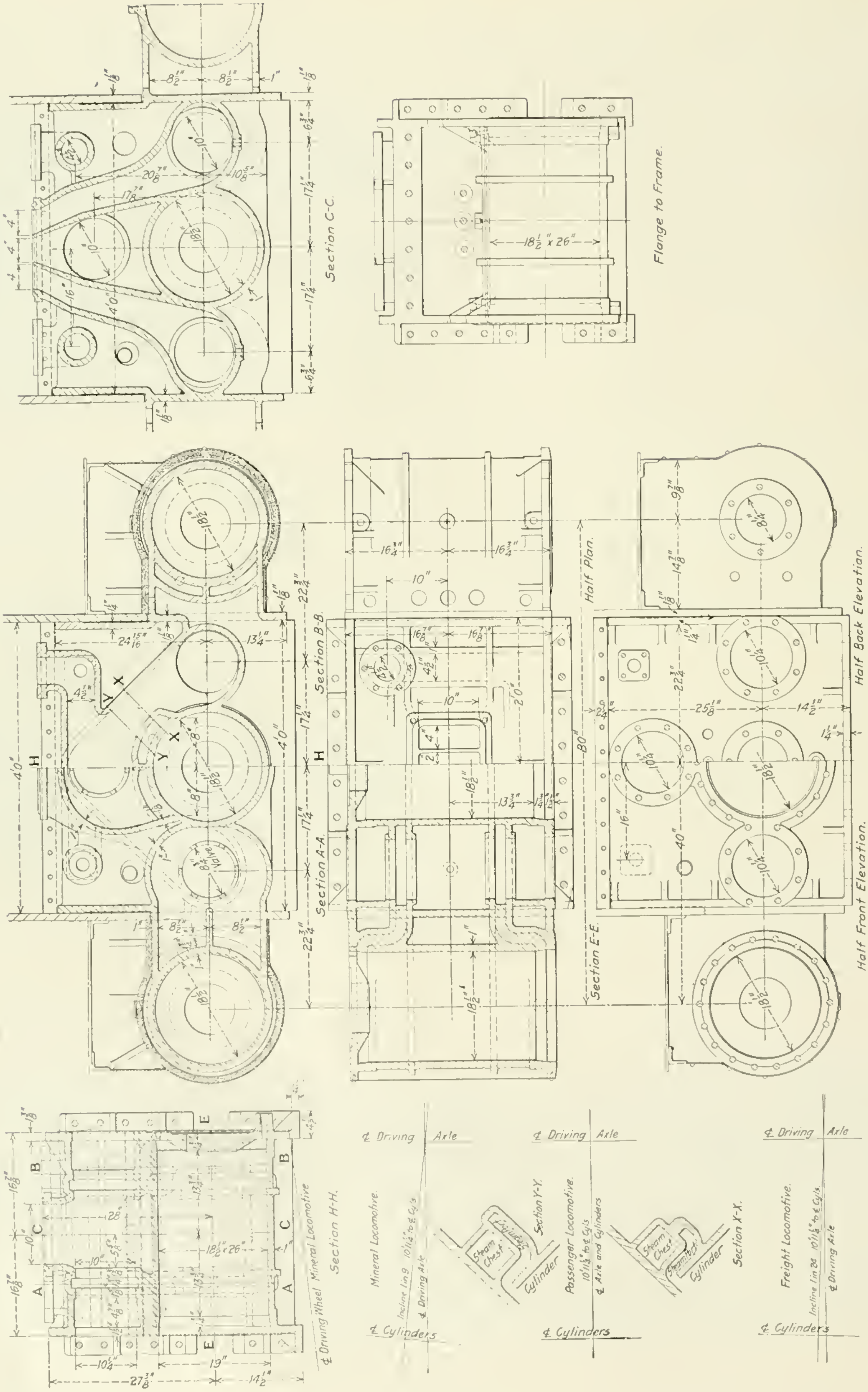


Fig. 7—Cylinders for North Eastern Three-Cylinder Mineral Locomotives

diameter which are held by cap nuts at the tube sheets. These are shown in the boiler drawing.

Contrary to a very general practice used in England and also on the North Eastern whereby an angle ring is used on the front end of the boiler to which is riveted the barrel and the front tube sheet, as indicated on the left hand of the boiler barrel shown in Fig. 11, the front tube sheet of this boiler is flanged and riveted directly to the boiler barrel. The back head is flanged on its periphery to provide for riveting it to the firebox wrapper sheet from the outside. Likewise a similar joint is made with the copper back sheet of the firebox and the back head at the door. This is not common practice in England, a door ring being the customary form of construction.

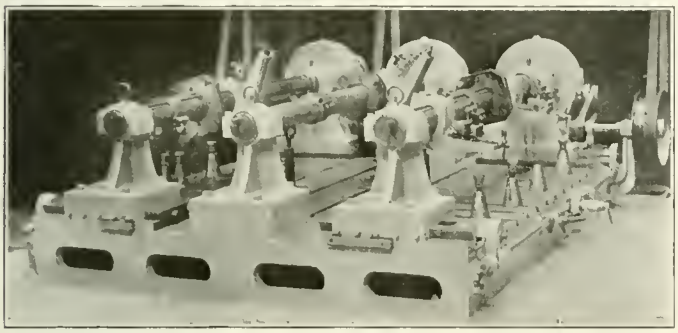


Fig. 8—Machine for Boring Cylinder Castings

It will be noted from the boiler drawing that the barrel courses are butt riveted on the circumferential seam. This practice is common throughout the English railways. After the barrel sheets have been trimmed and rolled they are held by straps of scrap iron bolted into "tack" holes which are drilled in the sheets before they are rolled. All three courses being treated in the same manner the process of assembling is as follows: The middle or dome course is placed end up on the floor. The circumferential welt plate, being bored to a diameter ⅛ in. less than the outside diameter of the boiler barrel, is heated to a cherry red and placed over the upper end of the dome course and held in position by tack bolts. The third barrel ring is then fitted into place by means of an overhead crane and is also held in place by tack bolts. The welt is thus shrunk on to the barrel sheets. (It should be mentioned, in passing, that the only holes drilled in these sheets and the welt strips are those necessary for holding them together with tack bolts. These holes are of a smaller diameter than the rivets and are redrilled as explained later.) With the second and third courses thus united the same process is carried through in applying the circumferential welt to the first and second courses.

After both rings have been put in place and securely fastened, and the longitudinal welt strips "tacked" in place, the boiler is taken to a boiler barrel drilling machine which is shown in Fig. 11. All rivet holes both for the longitudinal and circumferential seams are then drilled in this machine. This is done to obtain a true radial rivet hole and one that will exactly match in the welt strips and plate thus making any drifting unnecessary. After all the rivet holes have been drilled the longitudinal welt strips are removed and the surfaces of the boiler and welt strip thoroughly cleaned. Every hole is then slightly countersunk with a pneumatic

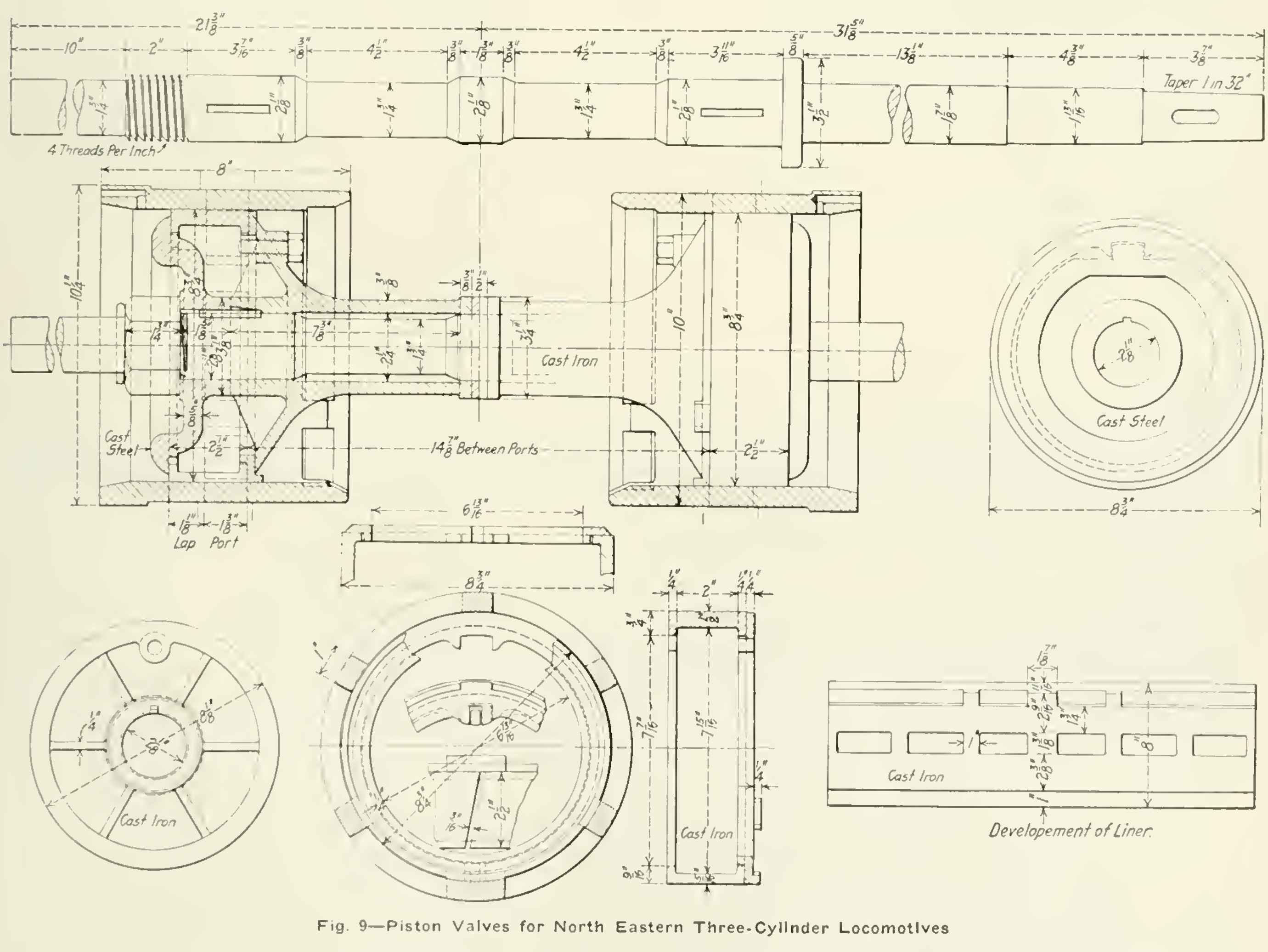


Fig. 9—Piston Valves for North Eastern Three-Cylinder Locomotives

rotary machine. The butt straps are again replaced and the boiler is ready for riveting in a bull riveter.

The rivet and staybolt holes in the firebox wrapper sheets and copper roof and side sheets are drilled on the flat to slightly less than the ultimate diameter, four or five sheets being drilled at a time with, of course, the top sheet being the only one "laid out." The sheets are then rolled to shape and after they are assembled, the rivet and staybolt holes are reamed out to the proper size.

All of the copper sheets are flanged by hand with the exception of the door-hole in the back firebox sheet which is done in a press. All the steel flange work is done in the hydraulic presses. After the back firebox sheet and the back head have been flanged and trimmed they are carefully fitted together at the door hole, distance pieces being placed between them to represent the water space. These plates are clamped together and the rivet holes through the two sheets drilled. The copper back firebox sheet is then taken to a machine and the door-hole machined out. Copper staybolts are used for the firebox. These are cut off to give a 7/16 in. stay head in the copper sheet and 3/8 in. head in the steel outside sheet. A long stroke pneumatic hammer with a pneumatic holder-on is used in riveting the stay bolts. The foundation ring, which in this case is 3 in. by 4 in., is machined on the outside and on the inside corners. In cases where steel fireboxes are used it is machined on both inside and outside.

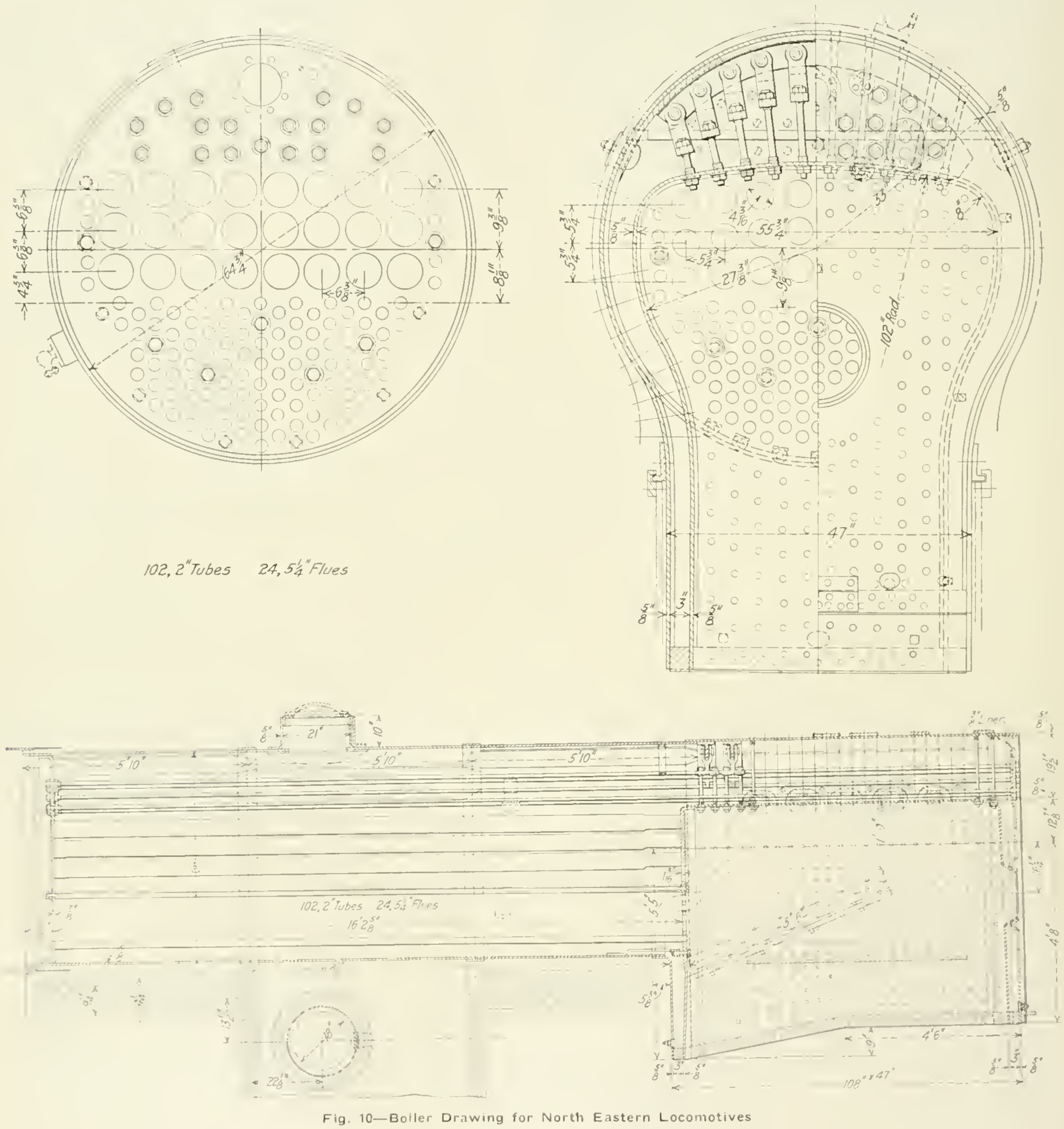


Fig. 10—Boiler Drawing for North Eastern Locomotives

While a large number of English roads use the ferrules between the tubes and the tube sheet, it is not the practice on the North Eastern. The tubes extend through the copper

tube sheet 3/8 in., for beading, and about 1/2 in. through the front tube sheet. The tubes are rolled by a three roller expander driven by a pneumatic portable machine and are beaded on the firebox end only, with the exception of the stay tubes which are beaded on both ends. The ends of the superheater flues extending through the firebox tube sheet are machined on the outside and care is taken to prevent any scale or foreign matter from working in between the sheet and the flue. These flues are then expanded by a special five roller expander and beaded as in the case of the small tubes.

The North Eastern has a particularly well equipped boiler

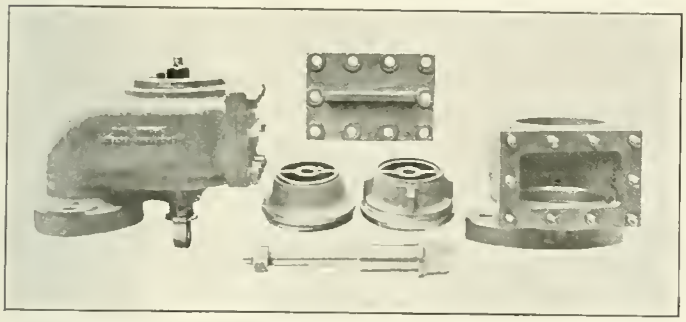


Fig. 12—Lockyer Double Beat Valve Showing Assembled Valve and Separate Parts

shop which is of sufficient capacity to more than take care of the needs of the road.

Special Attachments

Among the attachments to this locomotive may be mentioned the "Lockyer" double-beat throttle valve, designed by N. C. Lockyer, the works manager at Darlington. This is shown in Figs. 12 and 13. The purpose of this valve is to obtain a more nearly balanced valve than is possible with the ordinary construction of double seated valve. In order to do this it has been necessary to split the valve body into two parts as indicated in the drawing and illustration. The joint between these two parts is a carefully made steam tight fit. In this particular case the diameter of the upper and lower valve seats are exactly the same, being 6 1/8 in. This, of course, could not be obtained with the valve in one piece as it would be impossible to place the valve in position. This is overcome in the "Lockyer" valve by passing the lower portion of the valve through the opening at the

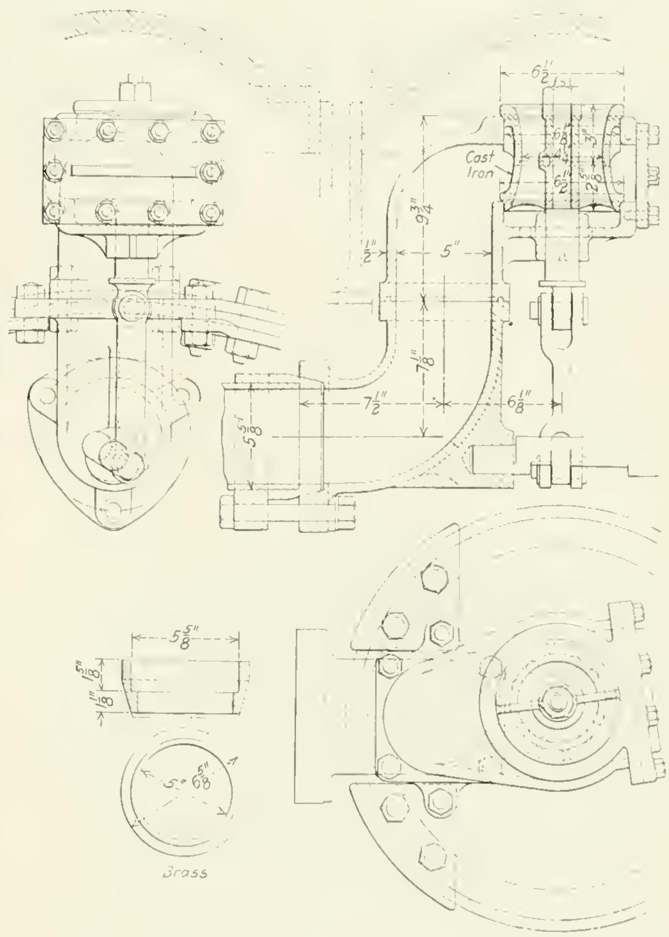


Fig. 13—Lockyer Throttle Valve for North Eastern Locomotives

right of the throttle pipe casting and putting the upper part through the top of the casting in the customary way, the two

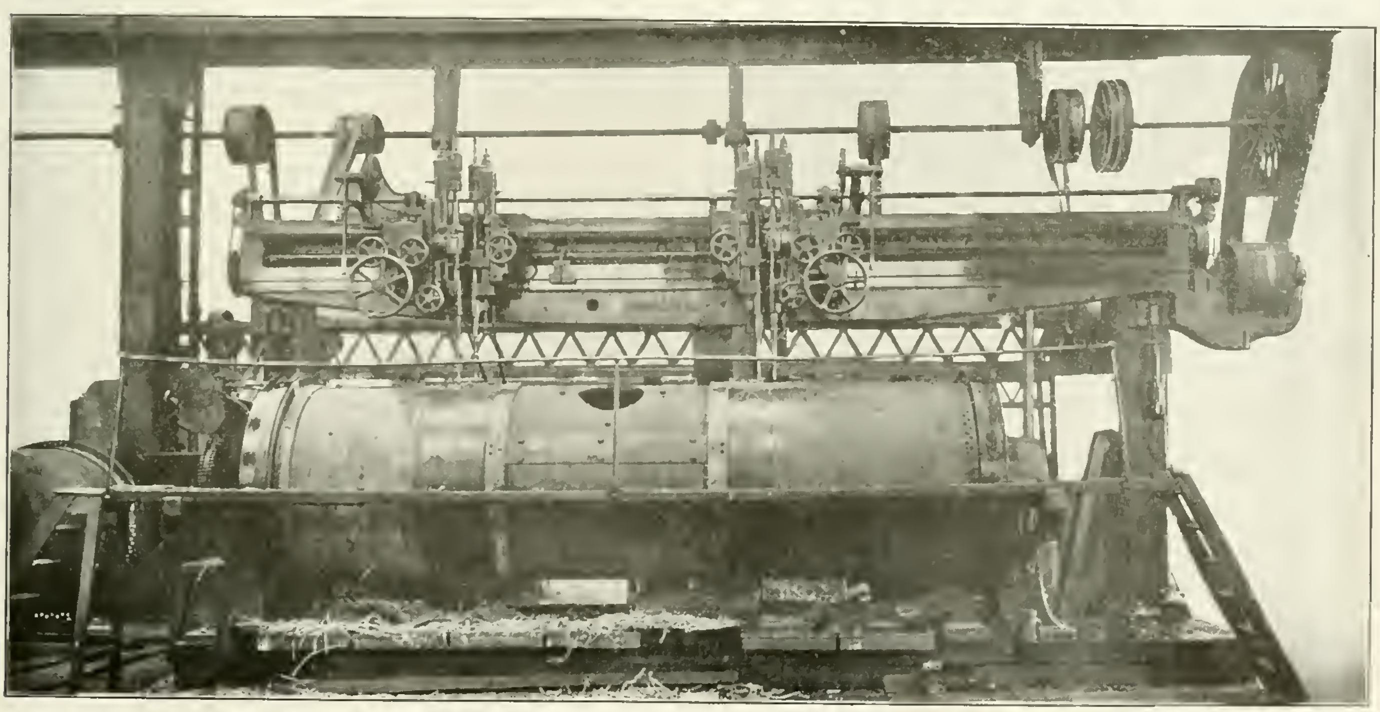


Fig. 11—Boiler Barrel Drilling Machine

parts fitting snugly to each other. They are bolted in position on a spindle. This construction permits of any combination of valve diameters desired.

It will be noted from the drawing that the upper valve has a conical baffle whereas the lower valve has a straight cylindrical base. This provides a gradual flow of steam into the dry pipe when the throttle is opened. There is an indicator placed on the throttle handle in the back head (Fig. 14) which gives the engineer indication of the throttle opening. The action of the baffles is such that the different positions of the throttle quadrant provide a steam area according to the following table:

Division of quadrant	Total area open to steam, square inches	Division of quadrant	Total area open to steam, square inches
1	0.00	7	7.74
2	0.54	8	10.62
3	1.08	9	13.32
4	1.62	10	16.38
5	2.83	11	19.98
6	5.22		

These engines are also equipped with a steam reversing mechanism which is indicated in the general arrangement drawing. The steam cylinders for operating the gear are located between the second and third drivers underneath the

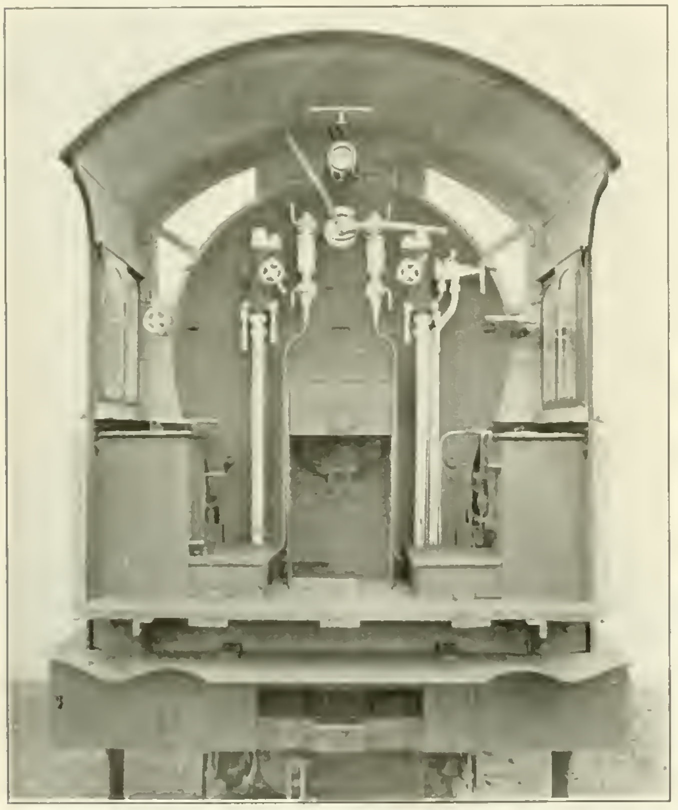


Fig. 14—Cab of North Eastern Mineral Locomotive

locomotive. The steam cylinder takes steam from the dome through a valve on the right hand side of the engine which is operated from the horizontal handle shown at the right of the cab in Fig. 14. This handle is attached to a rod, passing through the handrail, which is coupled to the control valve by a system of levers. The piston of the reversing mechanism is connected through a system of levers to an indicator in the cab which is shown indistinctly on the right hand side of the boiler head. The back head arrangement is characteristic of British practice.

General Dimensions

These engines are the latest to be constructed by the North Eastern and bear a great similarity to a 4-6-0 design, which is also new, for fast freight traffic. These engines use the same cylinder castings and the same boiler. The dimensions of the 0-8-0 type are given below:

Type	0-8-0
Gage	4 ft. 8½ in.
Service	Heavy freight
Fuel	Soft coal
Tractive effort	36,960 lb.
Weight in working order	160,380 lb.
Weight on drivers	160,380 lb.
Weight on engine and tender in working order	259,200 lb.
Wheel base, driving	18 ft. 6 in.
Wheel base, total	18 ft. 6 in.
CYLINDERS	
Kind	Simple
Number	3
Diameter and stroke	18½ in. x 26 in.
VALVES	
Kind	Piston
Number	3
Diameter	8¾ in.
WHEELS	
Diameter over tires	55¼ in.
BOILER	
Style	Straight
Working pressure	180 lb. per sq. in.
Outside diameter	66 in.
Firebox, length and width	9 ft. by 3 ft. 11 in.
Tubes, number and outside diameter	102—2 in.
Flues, number and diameter	24—5¼ in.
Stay tubes, number and diameter	7—2 in.
Tubes and flues, length	16 ft. 2⅝ in.
Heating surface, tubes	1,407 sq. ft.
Heating surface, firebox	166 sq. ft.
Heating surface, total	1,573 sq. ft.
Superheater surface	530 sq. ft.
Equivalent heating surface	2,368 sq. ft.
Grate area	27 sq. ft.
TENDER	
Tank	Six wheel
Weight	98,800 lb.
Water capacity	4,125 gallons
Coal capacity	5½ tons

ANTI-RUST COMPOUND

While statistics are not available, the total waste due to the rusting of machinery, tools, ordnance and metals amounts probably to millions of dollars annually. Various rust preventives invented and used from time to time have been more or less efficient in specialized fields. For example, paint is a most effective covering for products exposed to the weather. For bright polished steel surfaces, some form of heavy oil or grease is commonly used.

Experience with these compounds has developed the need for three inherent characteristics. First, they must form a protective covering and not melt easily. Under commercial conditions of storage and shipment, temperatures of 70 deg. F. to 100 deg. F., or higher, are common, and petroleum and other greases and compounds flow and drip off at these temperatures, exposing the bright surfaces to rust when the temperature has lowered and moisture collects on the metal. Second, they must be easily removed. Obviously a length gage, accurate to within .0001 in., cannot be covered with a compound that requires the application of emery cloth to remove it. The third requirement is ease of application.

A rust-preventing compound called Stazon, which is said to fulfill these three requirements, has been developed by the Conversion Products Corporation, New York. It is easily applied and removed by the simple act of wiping, and being an inert compound will not flow at high temperatures. To prove this fact a large number of trade-paper editors recently were invited to witness a demonstration. Four samples of anti-rust compounds, including Stazon, were placed on a metallic plate, the temperature of which was gradually raised by means of an electric resistance coil mounted on the back. The first compound started to melt at approximately 80 deg. F., and at 115 deg. F. three of the compounds had melted and completely run from the plate. Stazon remained and did not begin to soften until the temperature had reached over 200 deg. F., a temperature higher than would be found in any ordinary conditions of storage or shipment. It was stated that this compound when applied to metallic surfaces formed a coating impervious to moisture or atmospheric fumes.

Railroad and Industrial Shop Management

A Frank Discussion of the Situation in Railroad Shops Compared with Industrial Conditions

BY C. C. EDMONDS

THE unsolved problems in the motive power and car departments of a railroad are numerous and knotty, but some of them are quite evident to the shop man or foreman who is in constant contact with the work. My own experience which has covered a number of years and a variety of railroad shops and roundhouses has brought me into contact with some of the simpler problems involved in these departments.

The railroad method of doing things had always seemed about right to me until chance dropped me into the manufacturing of high grade machinery and tools. Although not high in the official realm of the various manufacturers with whom I came in contact, I did have opportunity to see new methods and new systems, and was able to contrast them with what I had seen during my railroad days. Consequently, when I returned to railroad work this contrast was decidedly marked and, I must confess, not exceedingly favorable to the manner in which railroad shops are managed. Realizing as I do that the typical railroad shop is not of the production or repetition type of industry and that the work cannot be centralized as in industrial practice, it still seems to me that on many points the railroads are decidedly weak.

Handicapped by Lack of Equipment and Materials

An illustration of how production is held up on many railroads is furnished by the present conditions in a 23-stall roundhouse in the Middle West. The machinists are all well equipped with hammers and chisels, but other than that their equipment is negative. There were only three pipe wrenches in the entire place, and it was a case of waiting until the other fellow was through with them. The back up belt on the one and only lathe has been off six weeks waiting for the stores department to issue a new one, but so far the prospects are that it will be several more weeks before the belt is forthcoming. An order for an emery wheel brings results within two months, if sufficient pressure is brought to bear. A much delayed order for sheet rubber for gaskets necessitated the use of canvas and varnish to make a gasket for an air compressor.

The idea of withholding supplies from the mechanical department in order to prevent wastage results in enough time being used in making parts to pay for them many times over. Personally, I have often had to make parts of such common accessories as gage cocks and boiler checks, not to mention robbing other engines of such parts as had not previously been appropriated.

The lack of shop equipment is particularly noticeable after one has been fortunate enough to work for a progressive industrial concern. Electric lights are a rare novelty in a majority of the round houses in the United States, and a new installation warrants a full page or two in the company magazine. It was once my ill-luck to desire electric lights for a shop of which I was night foreman. Consequently, I found a junk dealer who was willing to give me a generator, wire, etc., for a corresponding amount of old iron. By dint of much hard labor and "raids" on various other departments, the system was finally installed and extended so that it included the office, storehouse, engine despatcher's house and the machine shop. We were most jubilant about our improvement, and everything went serenely until the superintendent of motive power made a little inspection trip and, noticing our system, inquired as to our authority for the same. As we had none, his highness ordered the removal of our pet, so that the place has since been and is still illumined by lanterns and oil lights.

Previous to this occurrence we had been fortunate enough to make a trade with our junk man friend for an old air compressor, so that when it had been rebuilt we were well fixed for air pressure. This unauthorized move likewise caused considerable correspondence and orders concerning further procedure, but as the old air pump had been dismantled and sent to the shops there was no option about keeping the new addition, which is still running satisfactorily. However, if ever again I feel in the mood for making improvements in shop equipment they will first be sanctioned by higher authority and the material will be furnished on order. Initiative may be a virtue, but it is apt to get one into trouble in a railroad shop.

No Encouragement for the Foreman

Some time ago in the *Railway Mechanical Engineer* the life of a roundhouse foreman was aptly described by the author who said that if one wanted to find the foreman he needed merely to look around and if there was an engine with a dome cap off then undoubtedly the foreman's legs might be seen waving in the air therefrom. If the foreman could devote his entire time to the condition of his power this description would not be so absurd, but when we find the same man the next minute sweating over an elaborate report we can better appreciate his predicament.

Besides the task of planning shop work for the men, the foreman is inspector, disciplinarian, shop despatcher, turntable expert, call boy, employment manager, machinist, bookkeeper and office manager. The majority of foremen until recently have been absolutely overloaded with clerical details which are foreign to their training or inclination. In theory the roundhouse clerk was hired to keep the time books and attend to reports, but in practice the foreman usually had to recheck the entire outfit. A reduction of the variety of the foreman's duties would be a much needed step toward improvement. No foreman in a progressive industrial plant is harassed with so confusing a variety of responsibilities. He has the time and is generally permitted to plan his work deliberately, with the result that far more is in reality accomplished.

Many large industrial plants find that foremen's meetings held occasionally are of great value, and while the element of distance might interfere it would seem that quarterly meetings would be a big help to the foreman in giving him opportunity to acquire new ideas and to learn of new methods. The foreman could well be supplied with the current number of a good trade journal applicable to his particular work, so that he can keep ahead of the times.

In order to secure better and increased production, loyalty to the road must be secured. This can be gained only where both parties to the contract are fair and square. Men working in a shop, however large or small, notice the attitude of the management toward the foremen, and if it is a fair one the men respond favorably. Otherwise they figure, "Well, the company doesn't seem to care about its executives, and so why should I strive for promotion?" Wherever one goes and talks to railroad men he either discovers that "This company is all right and will take care of me," or "This company is n. g. and isn't interested in me." In the first instance he

will find that the men are loyal and will do the right thing by the company, while in the second case he will observe that it is a case of getting by as easily as possible and an "I-should-worry" attitude toward their work.

Push vs. Pull

Promotion on merit is greatly inducive to loyalty. If a man can be assured that he will be either promoted on his merits or fail if he does not qualify, he will work to the best of his ability. Otherwise, the better men will leave for other work because of lack of opportunities in railroading. I have had the privilege of talking to at least a dozen of the bigger railroad mechanical men throughout this country, and in every case when asked, "Would you want to go into it again?" they have said, "No, it's too hard a game and absolutely thankless." Such an attitude by the "big" men does not speak well for the attitude one must of necessity find in the ranks. For this reason railroading today cannot be said to be a very attractive profession or job for a well-trained young man as compared with opportunities in the industrial field.

Besides securing the right attitude of the men toward better production by securing more loyalty through right treatment of executives and fair promotion, much could be gained by the elimination of the present practice of "meeting the dividend period." In the case of most roads a big reduction in the number of mechanical employees is usually made about two months before the end of the fiscal year so that the net income can be boosted a bit thereby. In more than one roundhouse I have seen an entire emergency crew of machinists and boilermakers, plus a goodly quota of master mechanics and roundhouse foremen, trying to give the regular force a lift over a hard cold spell. Invariably one can find on inquiring of the foreman that engines were slipped by during the summer simply because of the approaching dividend period.

A Business Organization Needed

The presence of a good, well-balanced organization means that friction between departments and men is reduced to a minimum, while a loose organization means every department or man for itself or himself. An instance with which I am familiar will illustrate the average type of organization which one finds in the railroads today. At a division point into which three divisions ran from various directions (the division offices being at the other end of the line), the roundhouse foreman received a wire ordering him to get a certain extra engine there ready to go out light over division No. 1. Shortly afterward division superintendent No. 3 was wiring for the engine, and then the home division, or No. 2, also claimed the engine. (It was just out of the shop.) No one seemed to know whose engine it was, so the roundhouse foreman put it switching and sent the telegrams to the superintendent motive power for him to straighten out the mess. Instances like the above are happening every day on the various railroads, and the result is no one knows who actually is boss.

It would seem that as other large companies, especially manufacturers, have proved that organization does pay, the railroads could well afford to get a definite understanding of the problem and then put the solution down in the form of an organization chart so that every man could have some idea of what his authority covered and to whom he was responsible. The constant "passing the buck" from one department to another could be stopped by higher officials requiring that their men assume responsibility and take the burdens together with the benefits. At present too many executives are simply a screen through which complaints, etc., are sifted until the little fellow (the fine mesh screen) has to catch it all and take his officers' burden. A demand that officers assume their own liability and no other should be strongly enforced, and the presence of an organization chart, together with some few standard written instructions as to general practice, should be of benefit. The present financial situation of the railroads is such as to make unlikely any betterment in tools and equipment, but nevertheless a goodly saving could be accomplished if the organization tangles could be straightened out and permanently recorded. The main expense involved would be the use of good, ordinary common sense and an efficiency expert would not be necessary, as the railroad men have plenty of brains and ability if only they could be given a chance to use them.

NEW PIECE WORK SYSTEM IN GERMAN SHOPS

A new system of piece work, which is of the nature of profit sharing, has been introduced in the government's railway repair shops at Golm-Mark and has led to increased production. A commission composed of a works manager, a delegate of the workers and a railway official calculates the number of hours necessary for the performance of a certain piece of work, on the basis of actual experience and average production. By a special scheme the saving in cost resulting from the difference between the actual number of hours worked and the calculated number is shared between workers and employers. Each individual worker is paid according to output and capacity on a scale arranged between the management and the workers. The resulting average of hours and wage rates is that for which payment is agreed upon in the repair contract. If, for instance, the agreed average price per hour is 2.30 marks plus 180 per cent for general expenses (some such percentage is usually allowed to every firm of contractors as compensation for expenses) the following result will obtain.

A railway freight car, according to the standard calculated, requires 500 hours for repair. The work is actually performed in 408 hours, so that a saving of 92 hours is effected. Ninety-two, the number of hours saved, multiplied by 2.30 marks gives 211.60 marks. The 180 per cent for expenses amounts to 380.88 marks; the sum of the two is 592.48 marks. Half of this sum, or 296.24 marks, goes to the gang of 10 workers employed on the job. The combined wages of these 10 workers for the job in question were 947.90 marks. The extra compensation of 296.24 marks paid to them for the saving in time amounts, therefore, to somewhat over 31 per cent.

Newly employed workers are paid a share of the profits after 12 days' work with their gang. The standard number of hours fixed by the commission is not reduced when the worker receives higher wages.

According to Vorwaerts (Berlin) this system has already been in use in the workshops for four months. As a result production has increased 100 per cent. Another advantage is that the employment of supervisors has become unnecessary. Further, if any member of a gang shows a lazy disposition the other members refuse to incur the loss of profit involved and demand his dismissal.

Hardening Gages with Minimum Distortion.—One of the laws governing the hardening of steel which has recently been discovered is that quenching while crossing an arresting or recalescence point produces the least amount of distortion. This is borne out by experiments conducted at Goldsmith's College, London, described in a paper before the Institution of Mechanical Engineers. In endeavoring to produce screw gages of extreme accuracy the effect of variations in the quenching temperature on a large number of gages was checked. While no temperature was found at which the steel was not distorted, the experiments showed that parts quenched at 700 deg. C. (1,292 deg. F.) increased in length by .0002 in. in .7 in. of length, which is within a pitch tolerance of .0003 in. per in. of length. Such slight errors are not serious as they can be removed by a grinding or lapping, which is usually necessary to give the required finish.

How Front End Air Leaks Can Be Prevented

Some of the Bad Effects of Front End Air Leaks and Means for Their Correction

IT IS questionable if the serious effects of front end air leaks are fully appreciated and whether adequate measures are being taken to prevent their bad effects. The direct result of air openings in the front end is to reduce the vacuum in the smokebox and lessen the draft on the fire. This in turn necessitates the use of a smaller nozzle area to produce the desired draft. A reduced nozzle increases the back pressure in the cylinders, from which it is apparent that the efficiency of the locomotive is directly affected by air leaks in the smokebox.

It has been pointed out that these air leaks do not usually develop suddenly and that their effect on the draft is gradual. Consequently as the steaming qualities of the locomotive are gradually impaired the nozzle is invariably bushed down or a bridge is required. If these front end air leaks occurred suddenly their effect would be so noticeable that they would unquestionably be investigated and corrected.

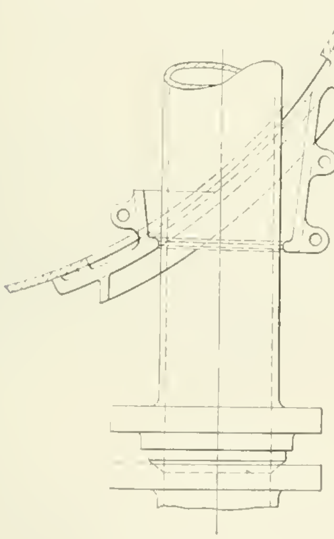


Fig. 1—Usual Type of Joint Between Smokebox and Outside Steam Pipe

The harmful effect of a front end air leak often remains after the leak itself has been stopped up, for after a nozzle has been bushed down or bridged to counteract the effect of an air leak in the front end, it is not always enlarged to its former dimensions as soon as the air leak has been closed. In fact, it is quite common for locomotives that have required a reduction in nozzle size for some cause or other, to keep on running with the reduced nozzle long after the immediate cause has been removed. Only the strictest supervision over this matter will result in the elimination of needlessly restricted nozzles.

Principal Cause of Front End Air Leaks

Outside steam pipes are not the only cause for front end air leaks but they can doubtless be regarded as the principal cause. The most troublesome point in connection with this construction has been to close the aperture in the smokebox shell through which the steam pipes pass to the cylinders. Obviously these pipes cannot be rigidly connected to the boiler shell at this point and must be allowed freedom of movement to allow for contraction and expansion. Outside steam pipes possessed so many advantages and adapted themselves so readily to superheater installations that the difficulty of maintaining a tight joint between the smokebox and the steam pipes was somewhat overlooked and the earliest joints intended to prevent air leaks have proved more or less inadequate from this standpoint.

Fig. 1 shows an arrangement that has been applied to a large number of locomotives. The gland is packed, preferably with asbestos rope, and if this packing is carefully maintained the joint will remain tight. However, it must be observed that the pressure on this packing, resulting from a vacuum in the front end, tends to loosen rather than compress the packing, and it will usually work loose so as to admit air, unless frequently attended to between shoppings. The use of any cement in this gland as a substitute or makeshift to reduce the time and expense of frequent repacking is not a desirable expedient. The cement soon develops cracks through which air is admitted to the smokebox, and often crumbles and drops out of the gland altogether. This is due to the fact that the cement contains moisture at the time the joint is packed which invariably dries out causing the packing to shrink around the steam pipes. The use of cement for this purpose cannot be too strongly condemned.

What Tests Developed

A simple torch test is all that is required to determine the presence of air leaks and it is earnestly recommended that this test be made *periodically* on *all* engines. At a single engine terminal recently where this test was applied at random to 29 engines, all but one were found to have air leaks around the steam pipe. On this railroad cement had replaced the asbestos packing and it was not the practice to test for air leaks unless the locomotive was reported for failure to steam. Similar tests conducted at terminals where the use of cement had not been resorted to developed a better state of affairs, but irrespective of the method of packing and even the type of construction, the entire elimination of front end air leaks can only be secured through the most vigilant inspection.

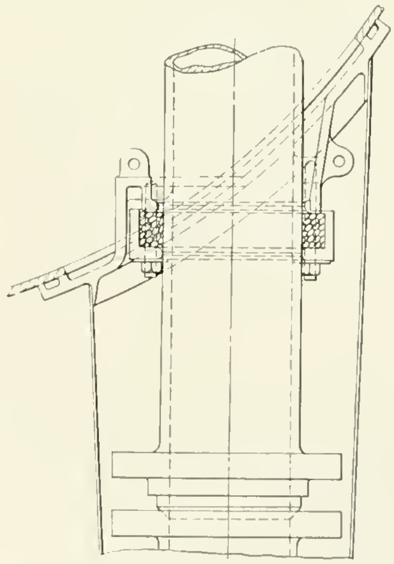


Fig. 2—Improved Type of Joint for Outside Steam Pipe

A test was conducted by the Fuel Conservation Section of the Railroad Administration for the purpose of determining the exact effect of reducing nozzles and disarranging

front end apparatus to overcome the effects of front end air leaks. In this test no particular locomotive was selected, the locomotive tested being one in regular chain gang freight service and assumed by all concerned to be in good condition. The first trip was made with the locomotive as found. On completion of the trip the openings around the steam pipes were packed with rope asbestos and it was found that this resulted in raising the average draft sufficiently to warrant an increase in the size of the nozzle. On the succeeding trip the openings around the steam pipes were again packed with asbestos and cement as a greater part of the packing had pulled out on the previous trip and a further enlargement of the nozzle was made. The results of successive test trips showed that with proper redrafting of the locomotive and stoppage of all air leaks, an increase of 9.3 per cent in the area of the exhaust nozzle was possible.

Improved Construction to Prevent Leaks

The use of a packing gland with means for maintaining the packing in place as shown in Fig. 2 is one of the most practical and certainly the most substantial means for obtaining a joint which, if properly packed, will remain tight from shopping to shopping. This form of construction was applied to quite a large number of locomotives, including

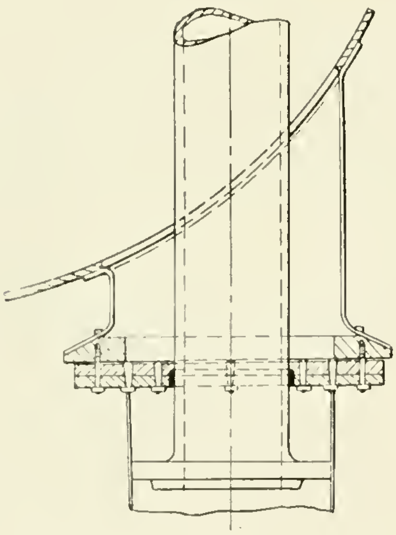


Fig. 3—Air Tight Joint Developed on Southern Pacific Lines

all of the locomotives built for the Railroad Administration. The application of this or an equivalent device to existing locomotives, as well as to all new power cannot be too strongly urged. The use of cement, as has been pointed out, is altogether unsatisfactory and the application of other material without means for holding it in place will necessitate frequent inspection and repacking.

Another form of construction designed to make the joint around the steam pipe air-tight which was first developed on the El Paso division of the Southern Pacific lines is shown in Fig. 3. The casing applied to the outside steam pipes is made of 1/4-in. steel plate with a welded seam. This casing is riveted permanently to the smokebox and then caulked or welded around the edge to make it air-tight. It is large enough in diameter to permit the removal of the steam pipes and a wrought iron ring is attached to the lower end as shown. A cast iron flange made in halves is fitted together and bolted snugly around the steam pipe, which is machined true at this point. The cast iron flange is secured to the wrought iron ring by means of studs and a copper wire gasket inserted to obtain an air-tight joint. A copper gasket is then caulked into a dovetailed groove in the cast iron flange surrounding the steam pipe.

Other Means for Correcting Leaks

Front end air leaks around the steam pipes may be corrected on a large number of locomotives on which this has been a source of trouble, by redesigning or inserting an effective packing gland to protect this joint. Fig. 4 illustrates a device that was designed to prevent air leaks around the outside steam pipes, but has never proved very satisfactory from this standpoint. On locomotives so equipped it would be better to discard all of this casing, except the flanged piece attached to the smokebox, and substitute a

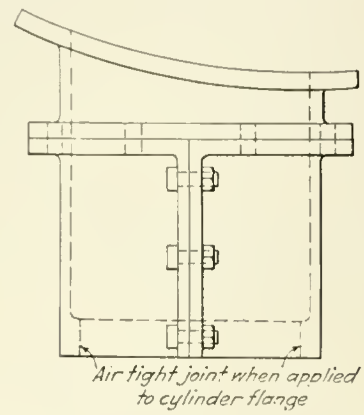


Fig. 4—Early Design to Prevent Air Leaks

stuffing box and packing gland as shown in Fig. 5, which, can be easily accomplished with the addition of two castings.

The problem of avoiding leaks at outside steam pipes is one that requires not only persistent attention in the engine terminal and shop, but should be carefully considered by mechanical engineers in designing new locomotives and improving old locomotives as they go through the shops. It is safe to say that wherever outside steam pipes are in use, a large percentage of locomotives will be found to have air

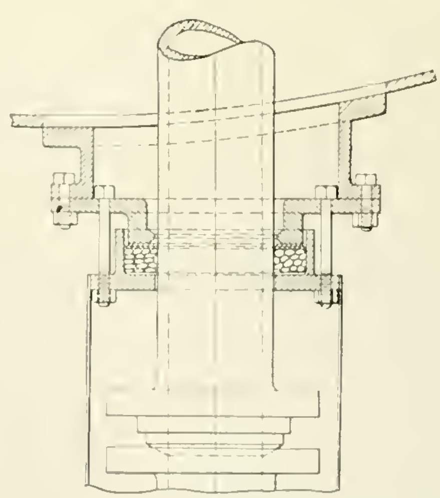


Fig. 5—Application of Stuffing Box and Gland to Design Shown in Fig. 4

leaks around the steam pipes, unless special precautions are taken in design as described in the foregoing, or unusual care is exercised with respect to this detail of locomotive maintenance. It is entirely possible that the design of an air-tight joint can be further improved, but it is of greater importance that the application of some of the improved designs already available be made more universal.

Individually, the front end air leak is never too small a matter to be overlooked and in the aggregate the loss in locomotive efficiency and capacity occasioned by front end air leaks will approach a surprising total on almost any railroad.

Railroad Labor Board Decision Announced

Total Award $600,000,000; Flat Increase of Thirteen Cents an Hour for Foremen, Mechanics and Helpers

THE United States Railroad Labor Board on July 20 announced its decision in the demands of the labor organizations for increased wages and changes in working conditions. The board reserved decision on the questions regarding working conditions and awarded flat hourly increases over the rates established by the Railroad Administration. The average increase is approximately 21 per cent of the present rates of pay and will add about $600,000,000 to the annual pay roll.

In separating the question of wages from related subjects such as the continuation or elimination of the National Shop Agreement and the application of the award to the various outlaw organizations, the board stated that adequate investigation and consideration of these questions would demand much time and because of the existing tense labor situation it was desirable to make as early a decision of the wage question as practicable.

The actual additions to the total payroll of the larger classes of employees (allowing nothing for overtime) are estimated as follows:

		Approximate percentage increase
Yardmasters and train despatchers	$4,767,357	
Clerks	103,920,176	25
Maintenance of way employees	160,297,568	25
Mechanics and shop laborers	139,237,215	19⅝
Agents and telegraphers	21,281,669	23
Enginemen	65,025,012	23
Trainmen	91,561,335	
Marine employees	250,000	
Total	$586,340,336	

The introduction to the board's decision reads in part as follows:

In arriving at its decision, the Board has taken into consideration, as the Transportation Act prescribes:

"(1) The scale of wages paid for similar kinds of work in other industries;

"(2) The relation between wages and the cost of living;

"(3) The hazards of the employment;

"(4) The training and skill required;

"(5) The degree of responsibility;

"(6) The character and regularity of the employment, and

"(7) Inequalities of increase in wages or of treatment, the result of previous wage orders or adjustments."

The Board has been unable to find any formula which applied to the facts would work out a just and reasonable wage for the many thousands of positions involved in this dispute. The determination of such wages is necessarily a matter of estimate and judgment in view of all the conditions; a matter on which individuals will differ widely as their information or lack of it, their interest, situation and bias may influence them.

With reference to "the character and regularity of the employment," the Board finds that with few exceptions railroad employment is more regular, and the character of the work is more desirable than like occupations outside. As a rule railroad employees are such for life and usually remain for years with the same company. This permanence of employment has certain advantages which have been considered by the Board. With regard to "the scale of wages paid for similar kinds of work in other industries," and "the relation between wages and the cost of living," the Board has been under some difficulty. It is clear that the cost of living in the United States has increased approximately one hundred per cent since 1914. In many instances the increase to employees herein fixed, together with prior increases granted since 1914, exceed this figure. The cost of living and wages paid for similar kinds of work in other industries, however, differ as between different parts of the country. Yet standardization of pay for railroad employees has proceeded so far and possesses such advantages that it was deemed inexpedient and impracticable to establish new variations based on these already variable conditions.

It has been found by this Board generally that the scale of wages paid railroad employees is substantially below that paid for similar work in outside industry, that the increase in living cost since the effective date of General Order 27 and its supplements has thrown wages below the pre-war standard of living of these employees and that justice as well as the maintenance of an essential industry in an efficient condition require a substantial increase to practically all classes.

During the hearings, the "International Association of Railroad Supervisors of Mechanics," and "The American Train Dispatchers' Association" have been made parties to this dispute. In granting hearings to them, this Board has not assumed or decided any question of jurisdiction between the several organizations or associations either parties to or outside of this dispute.

The Board assumes as the basis of this decision the continuance in full force and effect of the rules, working conditions and agreements in force under the authority of the United States Railroad Administration. Pending the presentation, consideration and determination of the questions pertaining to the continuation or modification of such rules, condition and agreements no changes therein shall be made except by agreement between the carrier and employees concerned. As to all the questions with reference to the continuation or modification of such rules, working conditions and agreements, further hearings will be had at the earliest practicable date and decision thereon will be rendered as soon as adequate consideration can be given.

After giving the names of the various railroads affected, the decision outlines in detail the increases in wages, which are as follows:

ARTICLE II.—CLERICAL AND STATION FORCES.

Add to the rates established by or under the authority of the United States Railroad Administration for each of the hereinafter named classes, the following amounts per hour:

Sec. 1. Storekeepers, assistant storekeepers, chief clerks, foremen, subforemen and other clerical supervisory forces..........13 cents.

Sec. 2. Clerks with an experience of one (1) or more years in railroad clerical work, or clerical work of a similar nature in other industries, or where their cumulative experience in such clerical work is not less than one (1) year..........13 cents.

Sec. 3. Clerks whose experience as above defined is less than one (1) year, and until an experience of one (1) year in such work entitles them to the increase provided for in Section 2..........6½ cents.

Sec. 4. Train and engine crew callers, assistant station masters, train announcers, gatemen and baggage and parcel room employees (other than clerks)..........13 cents

Sec. 5. Janitors, elevator and telephone switchboard operators, office station and warehouse watchmen, and employees engaged in assorting way bills and tickets, operating appliances or machines for perforating, addressing envelopes, numbering claims and other papers, gathering and distributing mail, adjusting dictaphone cylinders and other similar work....10 cents.

Sec. 6. Office boys, messengers, chore boys and other employees under eighteen years of age, filling similar positions, and station attendants..5 cents.

Sec. 7. Station, platform, warehouse, transfer, dock, pier, store-room, stockroom and team-track freight handlers or truckers, and others similarly employed..........12 cents.

Sec. 8. The following differentials shall be created or maintained, as the case may be, between truckers and the classes named below:

(a) Sealers, scalers and fruit and perishable inspectors, one (1) cent per hour above truckers' rates as established under Section 7.

(b) Stowers or stevedores, callers or loaders, locators and coopers, two (2) cents per hour above truckers' rates as established under Section 7.

The above shall not operate to decrease any existing higher differentials.

Sec. 9. All common laborers in and around stations, storehouses and warehouses, not otherwise provided for........................8½ cents.

ARTICLE III.—MAINTENANCE OF WAY; UNSKILLED FORCES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per hour:

Sec. 8. Laborers employed in and around shops and roundhouses, such as engine watchmen and wipers, fire builders, ash-pit men, flue borers, coal passers (except those coming under the provisions of Article VIII, Section 3, this decision), coal chute men, etc........................10 cents.

ARTICLE IV.—SHOP EMPLOYEES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per hour:

Sec. 1. Supervisory forces ....13 cents.

Sec. 2. Machinists, boilermakers, blacksmiths, sheet metal workers, electrical workers, carmen, moulders, cupola tenders and coremakers, including those with less than four years' experience, all crafts........13 cents

Sec. 3. Regular and helper apprentices and helpers, all classes..13 cents.

Sec. 4. Car cleaners ....5 cents.

ARTICLE V.—ESTABLISHES NEW RATES FOR TELEGRAPHERS, TELEPHONERS AND AGENTS.

ARTICLE VI.—ENGINE SERVICE EMPLOYEES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per mile, per hour, or per day, as the case may be, except in Section 4, as noted:

Sec. 1.—Passenger Service.

Class	Per mile, cents	Per day
Engineers and motormen	.8	$0.80
Firemen (coal or oil)	.8	.80
Helpers (electric)	.8	.80

Sec. 2.—Freight Service

Class	Per mile, cents	Per day
Engineers (steam, electric or other power)	1.04	$1.04
Firemen (coal and oil)	1.04	1.04
Helpers (electric)	1.04	1.04

Sec. 3.—Yard Service

Class	Per hour, cents
Engineers	18
Firemen (coal or oil)	18
Helpers (electric)	18

Sec. 4. Hostler Service

Note.—Superseding rates established by or under the authority of the United States Railroad Administration, and in lieu thereof, for each of the hereinafter named classes, the following increased rates are established:

Class	Per day
Outside hostlers	$6.24
Inside hostlers	5.60
Helpers	5.04

ARTICLE VII.—TRAIN SERVICE EMPLOYEES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per mile, per day, or per month, as the case may be, except in Section 4, as noted:

Sec. 1.—Passenger Service

Class	Per mile, cents	Per day	Per Month
Conductors	.67	$1.00	$30.00
Assistant conductors or ticket collectors	.67	1.00	30.00
Baggage men handling both express and dynamo	.67	1.00	30.00
Baggagemen operating dynamo	.67	1.00	30.00
Baggagemen handling express	.67	1.00	30.00
Baggagemen	.67	1.00	30.00
Flagmen and brakemen	.67	1.00	30.00

Sec. 2. Suburban Service (Exclusive)

Class	Per mile, cents	Per day	Per Month
Conductors	.67	$1.00	$30.00
Ticket collectors	.67	1.00	30.00
Guards performing duties of brakemen or flagmen	.67	1.00	30.00

Sec. 3. Freight Service

Class	Per mile, Cents	Per day
Conductors (through)	1.04	$1.04
Flagmen and brakemen (through)	1.04	1.04
Conductors (local or way freight)	1.04	1.04
Flagmen and brakemen (local or way freight)	1.04	1.04

Sec. 4 Yard Service

Note.—Superseding rates established by or under the authority of the United States Railroad Administration, and in lieu thereof, for each of the hereinafter named classes, the following increased rates are established:

Class	Per day
Foremen	$6.96
Helpers	6.48
Switchtenders	5.04

ARTICLE VIII. STATIONARY ENGINE (STEAM) AND BOILER ROOM EMPLOYEES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per hour:

Sec. 1. Stationary engineers (steam)........................13 cents.

Sec. 2. Stationary firemen and engine room oilers..........13 cents.

Sec. 3. Boiler room water tenders and coal passers............10 cents.

ARTICLE IX. REFERS TO SIGNAL DEPARTMENT EMPLOYEES

ARTICLE X.—ESTABLISHES NEW RATES FOR MASTERS, OFFICERS AND PILOTS OF RAILROAD FLOATING EQUIPMENT

ARTICLE XI. OTHER SUPERVISORY FORCES

Add to the rates established by or under the authority of the United States Railroad Administration, for each of the hereinafter named classes, the following amounts per hour:

Sec. 1. Train despatchers ....13 cents.

Sec. 2. Yard masters and assistant yard masters.............15 cents.

ARTICLE XII.—MISCELLANEOUS EMPLOYEES

Add to the rates established by or under the authority of the United States Railroad Administration, for employees in the hereinbefore named departments who are properly before the Board and not otherwise provided for, an amount (as per Section 3, Article XIII) equal to that established for the respective classes to which the miscellaneous classes herein referred to are analogous. The intent of this article is to extend this decision to a miscellaneous class of supervisors and employees, practically impossible of specific classification, and at the same time to insure to them the same consideration and rate increase as provided for analogous service.

ARTICLE XIII.—GENERAL APPLICATION

Sec. 1. The increases in wages and the rates hereby established shall be effective as of May 1, 1920, and are to be paid according to the time served to all who were then in the carriers' service and remained therein, or who have since come into such service and remained therein.

Sec. 2. The provisions of this decision will not apply in cases where amounts less than thirty dollars ($30.00) per month are paid to individuals for special service which takes only a portion of their time from outside employment or business.

Sec. 3. Increases specified in this decision are to be added to the hourly rates as established by or under the authority of the United States Railroad Administration for employees now being paid by the hour. For employees paid by the day, add eight times the hourly increase specified to the daily rate. For employees paid by the month, add two hundred and four (204) times the hourly rate specified to the monthly rate.

Sec. 4. Each carrier will in payment to employees on and after August 1, 1920, include therein the increases in wages and the rates hereby established.

Sec. 5. The amounts due in back pay from May 1, 1920, to July 31, 1920, inclusive, in accordance with the provisions of this decision, will be computed and payment made to the employees separately from the regular monthly or semi-monthly payments, so that employees will know the exact amount of their back payments:

Recognizing the clerical work necessary to make these computations for back pay and the probable delay before the entire period can be covered, each month, beginning with May, 1920, shall be computed as soon as practicable, and as soon as completed, payment shall be made.

Sec. 6. The increases in wages and the rates hereby established shall be incorporated in and become a part of existing agreements or schedules.

Sec. 7. Except as specifically modified herein, the rules regulating payments of overtime or working conditions in all branches of service, and the established and accepted method of computing time and compensation thereunder, shall remain in effect until or unless changed in the manner provided by the Transportation Act, 1920.

Sec. 8. It is not intended in this decision to include or fix rates for any officials of the carriers affected except that class designated in the Transportation Act of 1920, as "Subordinate Officials," and who are included in the act as within the jurisdiction of this Board. The Act provides that the term "Subordinate Officials" includes officials of carriers of such class or rank, as the Interstate Commerce Commission shall designate by regulation duly formulated and issued. Hence, whenever in this decision words are used, such as "foremen," "supervisor," etc., which may apply to officials as are now or may hereafter be defined and classified by the Interstate Commerce Commission as such subordinate officials.

ARTICLE XIV.—INTERPRETATION OF THIS DECISION

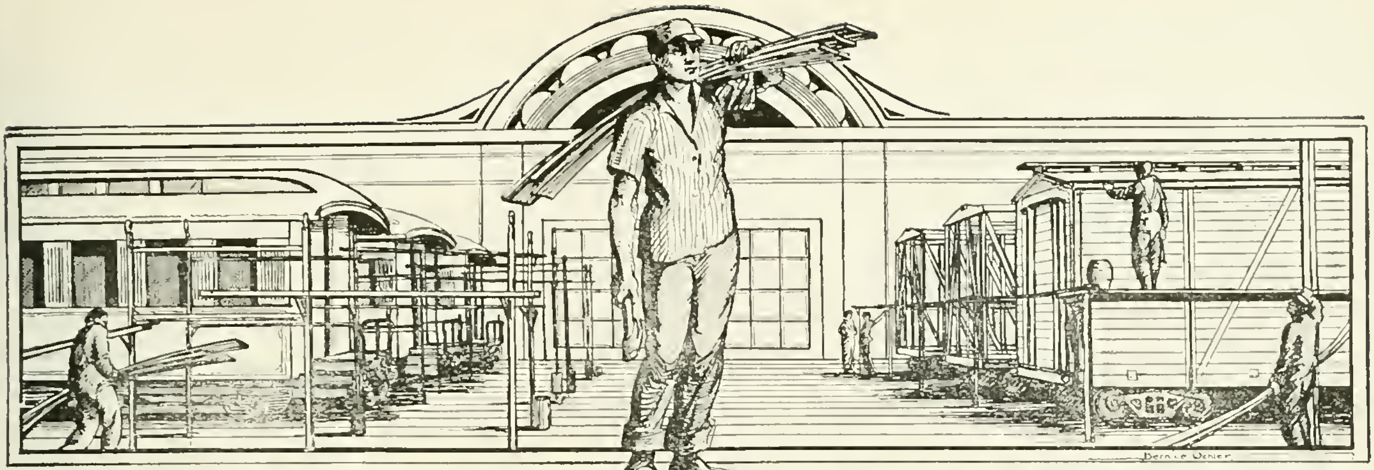
Sec. 1. Should a dispute arise between the management and the employees of any of the carriers as to the meaning or intent of this decision, which cannot be decided in conference between the parties directly interested, such dispute shall be referred to the United States Railroad Labor Board in the manner provided by the Transportation Act, 1920.

Sec. 2. All such disputes shall be presented in a concrete joint signed statement setting forth: (1) the article of this decision involved. (2) the facts in the case. (3) the position of the employees, and (4) the position of the management thereon. Where supporting documentary evidence is used it shall be attached in the form of exhibits.

Sec. 3. Such presentations shall be transmitted to the Secretary of the United States Railroad Labor Board, who shall place same before the Board for final disposition.

By order of the Chairman.

The representatives of the labor organizations held sessions after the award was announced, but were unable to come to an agreement regarding the action to be taken. Five of the organizations accepted the award outright. Of the shop crafts unions the Railway Employees Department of the American Federation of Labor referred the award to the employees without recommendation. The Sheet Metal Workers' International Alliance, the Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, the Brotherhood of Railway Car Men of America, the International Brotherhood of Electrical Workers, the International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America, and the International Brotherhood of Blacksmiths, Drop Forgers and Helpers referred it to the membership and recommended its acceptance.



CAR DEPARTMENT

Construction of Steam Hose

Earlier Data Contradicted. Tests Show Duck with Braid Inferior to Duck Alone. Seamless Tube Best

At the 1919 convention of the American Society for Testing Materials there was presented a paper on steam hose for car heating by H. J. Force.* This paper discussed tests of hose made from duck alone and from duck with one or more layers of braiding, and also compared the service of machine-made tubes with three-ply calendered tubing. As a result of these tests the author recommended that steam hose should be made of a composition of duck and braid and that the machine-made tubes should not be used, tubing of three-ply calender being applied in every case on hose which is to be subjected to any considerable degree of temperature.

At the convention of this association held in June, 1920, John M. Bierer, in a paper on the construction of steam hose, described three series of tests which also compared the effect of differences in the tube and fabric. The conclusions reached by the three investigators are opposed to those given in Mr. Force's paper. A summary of the paper by Mr. Bierer is given below.

Steam hose can be constructed with a seamless machine-made tube, or with a tube plied from calendered stock. Furthermore, the hose can have for its fabric element a duck of given weight and number of plies or a combination of plied duck and one or more plies of braid. To determine whether it is more satisfactory both to user and to manufacturer to make a seamless or a plied tube, and to make a simple multiple-ply duck construction or a combination duck and braid construction, three series of tests, carried out individually and independently by the B. F. Goodrich Co., the Goodyear Tire and Rubber Co., and the Boston Woven Hose and Rubber Co., have been made, the results of which are here shown.

The actual steam hose tested by the three investigators was obviously of different material, particularly as to compounds, so it is enlightening to survey the different series separately in order not to make the materials a factor in any comparison of constructions.

The tests by the B. F. Goodrich experimenters endeavored to compare both seamless with plied tubes and simple duck with duck-braid construction. All samples were 1⅝ in. in inside diameter, with tube ⅛ in. thick, cover 1-32 in. thick, duck 20 oz. per sq. yd., and braid 12 2-3 yarn. The hose was tested in a vertical position (so as not to have condensed steam present), under intermittent steam pressures, ten hours under pressure and two hours rest, until failure.

The results of the Goodrich tests are summarized in Table I. Each result represents an average of five individual samples of each construction.

Sample *B* was of distinctly lighter weight than *A* or *C*, so it is not surprising that failure occurred earlier than the A and *C* samples, which were comparable to each other. *C* and *D* were different only in the construction of tube, so that the longer service of *C* was undoubtedly due to the absence of seams, joints, or plied surfaces, which tend to open up. Similiarly, *A* and *C* were different in fabric construction, with the same tube, so that the better endurance of *C* can safely be laid to the superiority of the simple plied duck to the braid and duck construction.

It takes little studying of these experiments to notice two facts already known to many familiar with steam hose. The steam hose with seamless tube lasted about half again as long as that with a plied tube; and likewise the hose with simple duck of sufficient plies lasted about half again as long as the hose with a combination of duck and braid.

Summarizing the experiments of the Goodyear Tire and Rubber Co., there appears a series of similar results. Table II represents an average of five individual samples of each construction. Comparison is offered in this series also of seamless and plied tubes, of duck and duck-braid constructions, and of expansion and contraction measurements as well. Like the Goodrich tests, the hose was tested ten hours

Table I. Results Obtained in Tests by B. F. Goodrich Co.

	Sample			
	A	B	C	D
Number of plies of duck	3	4	6	6
Number of plies of braid	2	0	0	0
Tube	Seamless	Seamless	Seamless	Plied
Endurance under 60-lb. pressure, hours	2,261	904	3,143	2,170

*See Railway Mechanical Engineer for September, 1919, page 527.

under 60 lb. steam pressure and two hours rest until failure.

Owing to details of manufacture, there is necessarily not found the same percentage ratios of endurance among the various constructions that were found in the Goodrich tests, but inspection of the results will reveal certain facts more important than this detail. The hose with the seamless tube *C* outlasted that with the plied tube *D* and the hose with the simple plied duck construction *C* outlasted that with a combination of duck and braid *E*. These results, though not so strikingly shown, are in accordance with those obtained in the Goodrich experiments. A further feature should be noted, that though the expansion in lateral dimensions and contraction in length are favorable to the duck-braid construction, the difference is so small between the two styles that any real and practical superiority for the braided hose would be negligible in practice.

The next experimental data to show divergence among the constructions are those obtained at the Boston Woven Hose and Rubber Co. laboratories. In order to determine the relative value of a hose with simple plied duck and hose with a combination of duck and braid, and to determine the relative value of seamless tubes and plied tubes, the following constructions were given prolonged tests. All

Table II.—Results of Experiments of Goodyear Tire and Rubber Co.

	Sample				
	A	B	C	D	E
Number of plies of duck	2	4	6	6	3
Number of plies of braid	2	0	0	0	2
Tube	Seamless	Seamless	Seamless	Plied	Seamless
Endurance under 60-lb. pressure, hours	1,506	1,198	1,624	1,493	1,612
Expansion of diameter in 1,000 hours, per cent	6.1	12.2	8.2	8.1	7.0
Contraction in length in 1,000 hours, per cent	1.6	3.2	3.7	3.6	1.8

hose was of 1-in. inside diameter ⅛-in. tubes, 0.050-in. covers and was tested in 3-ft. lengths. Two series of tests were carried out: the first at 60-lb. steam pressure intermittently 124 hours on and 44 hours rest, the second continuously at 180-lb. pressure, both until failure. Eight individual samples were tested in each series and the results summarized are an average of these:

For a given fabric construction, hose with seamless tubes *A* lasted about one-fifth again as long and *B* almost twice as long as those with plied tubes *C* and *D*. Furthermore, for the same style of tube, hose with simple plied duck *A* lasted half again as long, and *C* over twice as long as those with duck and braid construction *B* and *D*.

In these tests, owing to particularly careful workmanship on the samples, failure was not due primarily to separation of the seam or joint on the inner surface of the tube. But in the ordinary process of manufacture, without such undue care and special attention, the plied tube is always a danger, and this splitting and opening up of the tube is practically a fatal objection to the success of any hose by this method. This series is a clear case of superiority of seamless tubes over plied tubes, and of simple plied duck over a combination duck and braid construction.

Table III. Results Obtained by the Boston Woven Hose and Rubber Co.

	Sample			
	A	B	C	D
Number of plies of duck	6	3	6	3
Number of plies of braid	0	2	0	2
Tube	Seamless	Seamless	Plied	Plied
Endurance under 60-lb. intermittent pressure, hours	2,607	1,770	2,143	950
Endurance under 180-lb. constant pressure, hours	67	26	62	17

Conclusions

Three different experimental laboratories, working individually and independently, found consistent results in an effort to determine the relative values of seamless and plied tubes, and of simple duck and duck supplemented by braiding. From the data gathered, there are two conclusions concerning these relative values which are obvious and irrefutable:

1. Steam hose made with seamless tubes (in practice by the tube-machine method) is superior in endurance under steam pressure to hose with tubes made up of successive plies of a sheeted stock, sometimes known as a calendered tube. The hose with plied tubes was found to fail by the splitting and separation of the seam necessarily formed at the surface of the tube in its construction.

2. Steam hose with its fabric constructed of successive plies of frictioned duck is superior in endurance to, and the practical equal in expansion and contraction of, hose made of a fewer number of plies of duck supplemented by plies of braiding.

The inevitable conclusion must be that it is most advantageous to the user and to the manufacturer alike to construct steam hose with a seamless tube and for its fabric element sufficient number of plies of duck only.

CHANGES IN THE RULES OF INTERCHANGE

The following modifications in the Rules of Interchange have been approved by the Executive Committee of the American Railroad Association and issued as Circular S III—163.

Effective March 1, 1920, all modifications of these rules having special application only to railroads under U. S. Federal control are cancelled, being superseded by the General Rules.

Rule 3.—The effective date of Section (d) of this rule has been extended to October 1, 1922, and the rule modified to read as follows:

Cars built prior to October 1, 1915, will not be accepted in interchange after October 1, 1922, unless equipped with A. R. A. Standard axles.

The effective date of Section (i) of Rule No. 3 has been extended until October 1, 1922, and the rule modified to read as follows:

After October 1, 1922, no cars with trucks of less than 60,000 lb. capacity will be accepted in interchange unless equipped with wooden or metal draft arms extending beyond body bolster, metal draft arms integral with body bolster, metal draft arms extending to body bolster and securely riveted to same, or transom draft gear.

Effective August 1, 1920, Rule 93 is modified to read as follows:

Separate bills shall be rendered for cars destroyed.

Separate bills shall be rendered for the periodical repacking of journal boxes.

All charges for repairs made to cars on account of owner's defects, defect cards and rebuttal authorities shall be consolidated against any one company into one bill; however, separate bill shall be rendered for the period subsequent to February 29, 1920.

Separate statements to be made.

1. For owner's defects for each calendar month.
2. For all charges based on defect card, including rebuttal charges.

Note.—Totals only of these statements to be shown on the recapitulation.

The title and address of the officer to whom correspondence should be forwarded relative to exceptions to charges should appear on the bill.

This circular should be considered as a supplement to the Rules of Interchange, and necessary instructions issued to all concerned. These modifications to the Rules of Interchange will be incorporated in the next supplement issued to these rules.

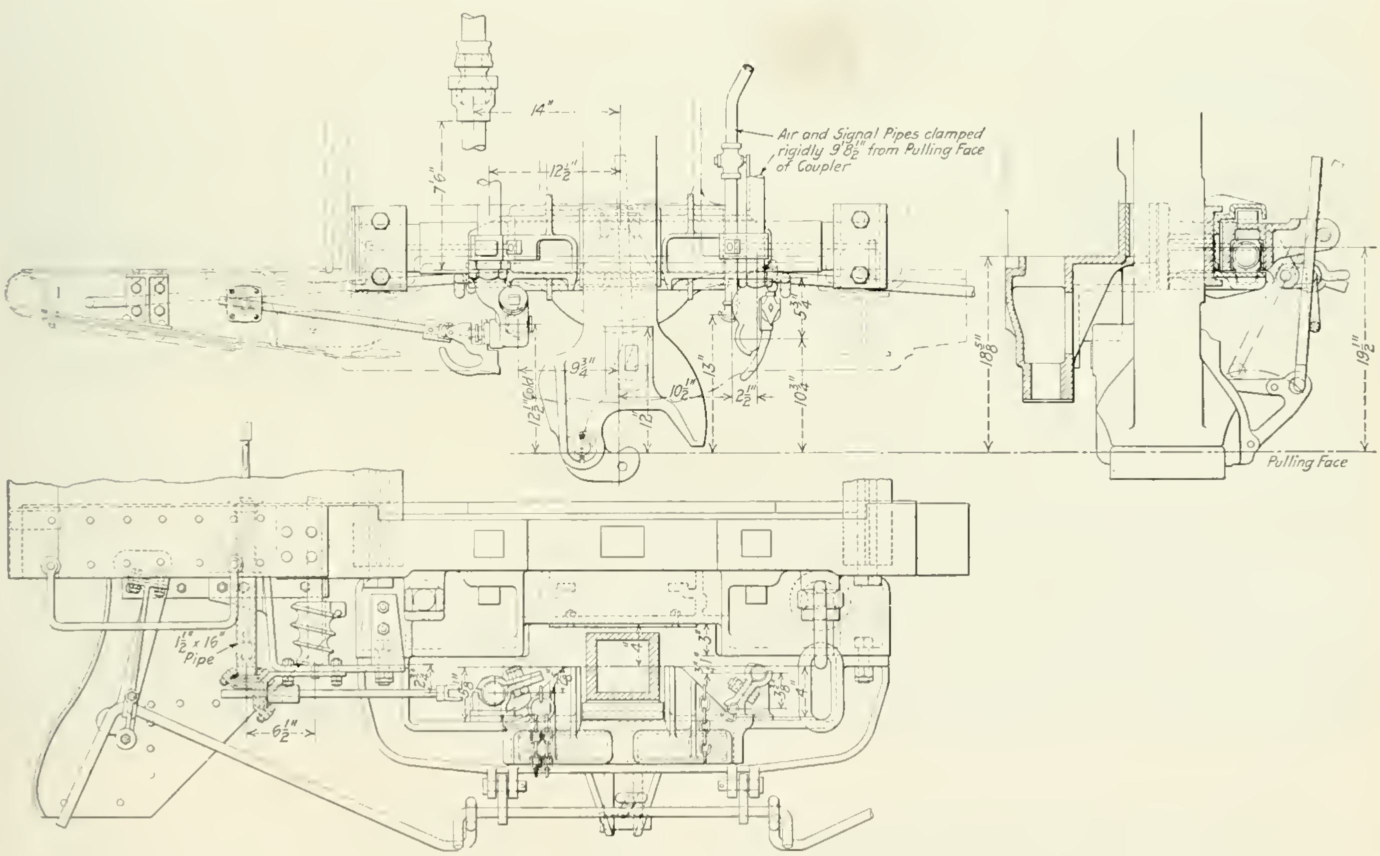
The Type "D" Coupler in Passenger Service

Difficulties Involved in Its Application; How the Problem Was Solved on New Pullman Cars

The first application of the standard Type "D" coupler to passenger equipment has been made by the Pullman Company on the new sleeping cars which are now being built at a rate to approximate an output of about 600 cars a year. Adaptation of the Type "D" coupler to passenger cars, without alteration from its standard form as designed for freight service, involves considerable difficulty, its large over-all dimensions causing it to interfere with the standard location of the train pipe connection. The trouble occurs on the knuckle or operating side of the coupler, which at its widest point extends about 7¾ in. from the center line of the stem.

The standard location of train pipe connections requires a distance of 20 in. between the center of the connection for the signal hose and that for the steam hose, with the steam hose connection 9½ in. from the center line of the car. With the steam-heat connection but 12 in. back of the inside face of the coupler knuckle, it will be seen that with the draft gear compressed there is very little clearance between the steam end valve and the side of the coupler when the coupler stem is on the center line of the car. This clearance is entirely inadequate to take care of the lateral swing of the coupler in curving. To increase the distance of the steam hose connection from the center line of the coupler would require a corresponding decrease in the distance from the center line of the coupler to the brake and signal hose connections, as the total distance between the two sets of connections is fixed and cannot be varied without requiring an entire readjustment of hose lengths. To move these connections over, however, in order to increase the clearance between the coupler and the steam end valve would tend to shorten the distance between the brake and signal hose connections and increase the distance between the steam hose connections on the adjoining ends of coupled cars. This condition, combined with certain conditions encountered in curving, would tend to cause the coupled steam hose to raise and separate the air hose couplings.

The solution finally arrived at by the Pullman Company and worked out for application on the sleeping cars now being built, is shown in the illustrations. Essentially this scheme involves the maintenance of a fixed relation between the center line of the coupler shank and the pipe connections, the latter being carried with the coupler in its lateral motion. This was accomplished by the design of a special coupler carrier casting with a long bearing face on which was placed a sliding saddle carrying the coupler and the ends of the train pipes. The bearing surface of the coupler carrier casting has a width of 4¾ in. and a total length of 38½. The coupler saddle casting is 29 in. long.



Application of the Type "D" Coupler to Pullman Cars

Between the top and bottom flanges of the I-section of the carrier casting the web member is omitted for a distance of 20 in. at the center to accommodate a centering spring and followers. With the spring and followers inserted, the saddle casting is placed over the carrier casting, pockets in the sides of the saddle being provided for the ends of the followers. The single coil spring is assembled with an initial load of 200 lb. and has a full load of about 600 lb. under the maximum travel of the saddle of 5½ in. either way from the center. The coupler stem has a clearance of ¾ in. on either

side from the vertical retaining faces of the saddle casting to take care of the angularity of the stem with relation to the saddle under maximum lateral movement.

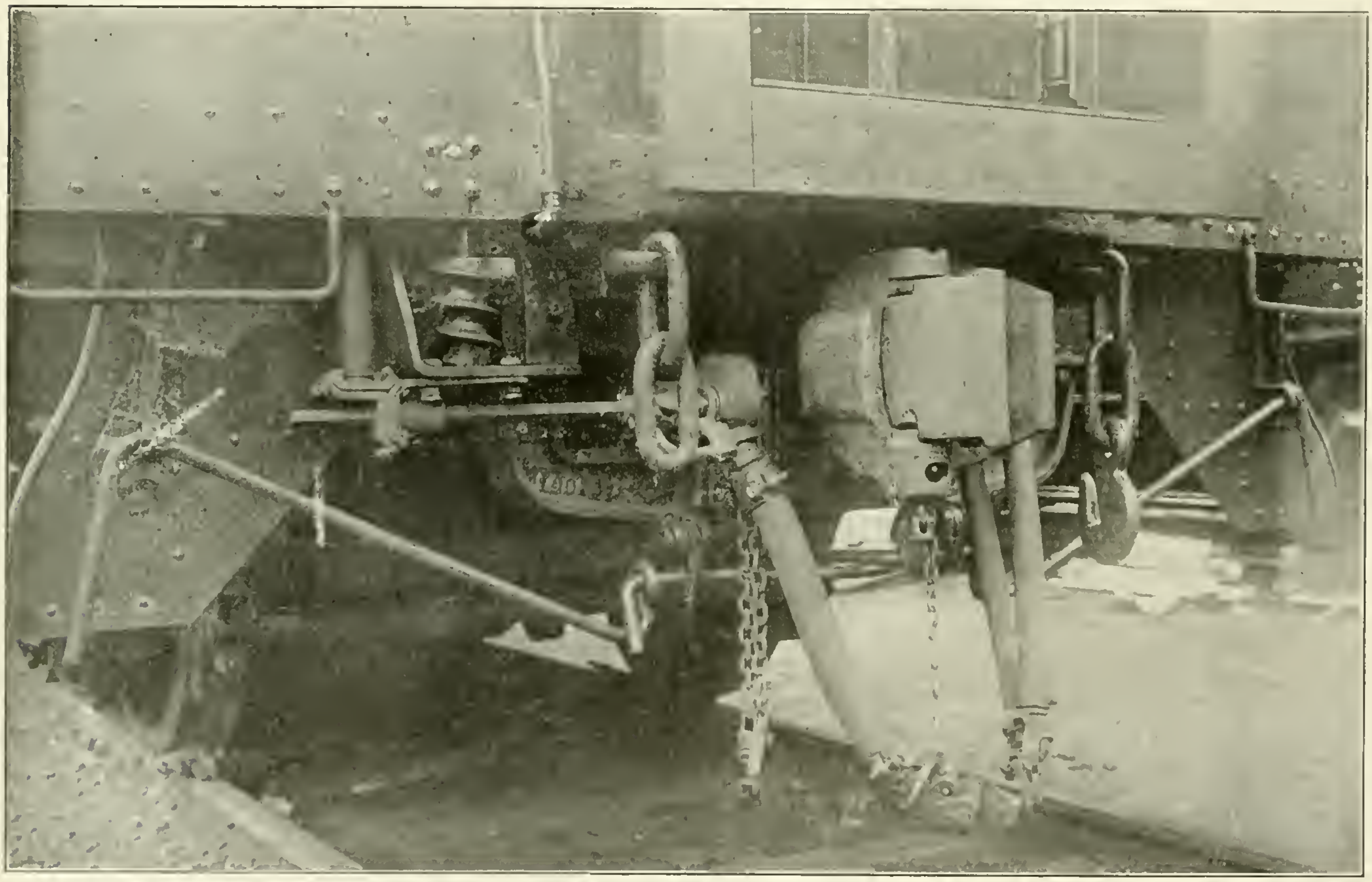
Both the carrier and saddle casting are relieved of lateral strains by the design of the platform and casting, which extends out at either side of the coupler shank to provide lateral stops. The coupler carrier is a steel casting while the saddle is of malleable iron with a movable shoe to take the wear of the coupler stem.

Brackets for support of the brake, signal and steam heat pipes are cast integral with the saddle casting. The brake and signal pipes are fastened with a single clamp which holds them rigidly in place. The steam pipe clamp is designed to close without tightly gripping the pipe, in order to provide for longitudinal expansion.

One of the problems which had to be solved in developing this arrangement was the provision of the necessary flexibility in the pipes to permit the required amount of lateral motion. The air pipes offered no particular difficulty, as it was found that by locating the first clamp a distance of 9 ft. 8½ in. from the end of the car sufficient flexibility was provided in the pipe itself to take up the lateral motion without undue stress. Inasmuch as there are two rigid clamps between the end of the car and the first pipe joint no trouble is anticipated in maintaining tight train lines.

It was found, however, that the 2-in. steam heat pipe was too large to take up the lateral motion without unduly stressing the joints and making it impossible to keep them tight. A Barco universal joint was therefore inserted in the pipe at a distance of about 7 ft. 6 in. back of the end valve. One of the interesting problems encountered in this connection was the difficulty of maintaining a tight joint between the end of the pipe and the bronze ball joint member. This was overcome by threading the end of the ball joint member on the outside and inserting it inside the steel pipe connection, the difference in expansion of the two metals thus tightening instead of loosening the joint.

Probably the most difficult problem encountered in working out the details of the flexible pipe arrangement was that of providing a satisfactory mechanism for operating from inside the vestibule the movable steam heat end valve. The device by which this is accomplished is simple, self-contained, and requires little special care in locating it on the car to insure freedom of operation. The motion of the vertical operating shaft is transmitted to the valve through bevel gears to a horizontal sliding shaft of square section. The cored hole through the hub of the lower gear is tapered from its smallest section in the middle toward each end, thus providing for considerable angular movement as well as the longitudinal movement of the horizontal shaft, to take care of the effect of expansion and contraction of the steam pipe, the lateral movement of the end and slight variations in the relationship of parts in assemblying.



End View of a Pullman Car With Type "D" Coupler Application

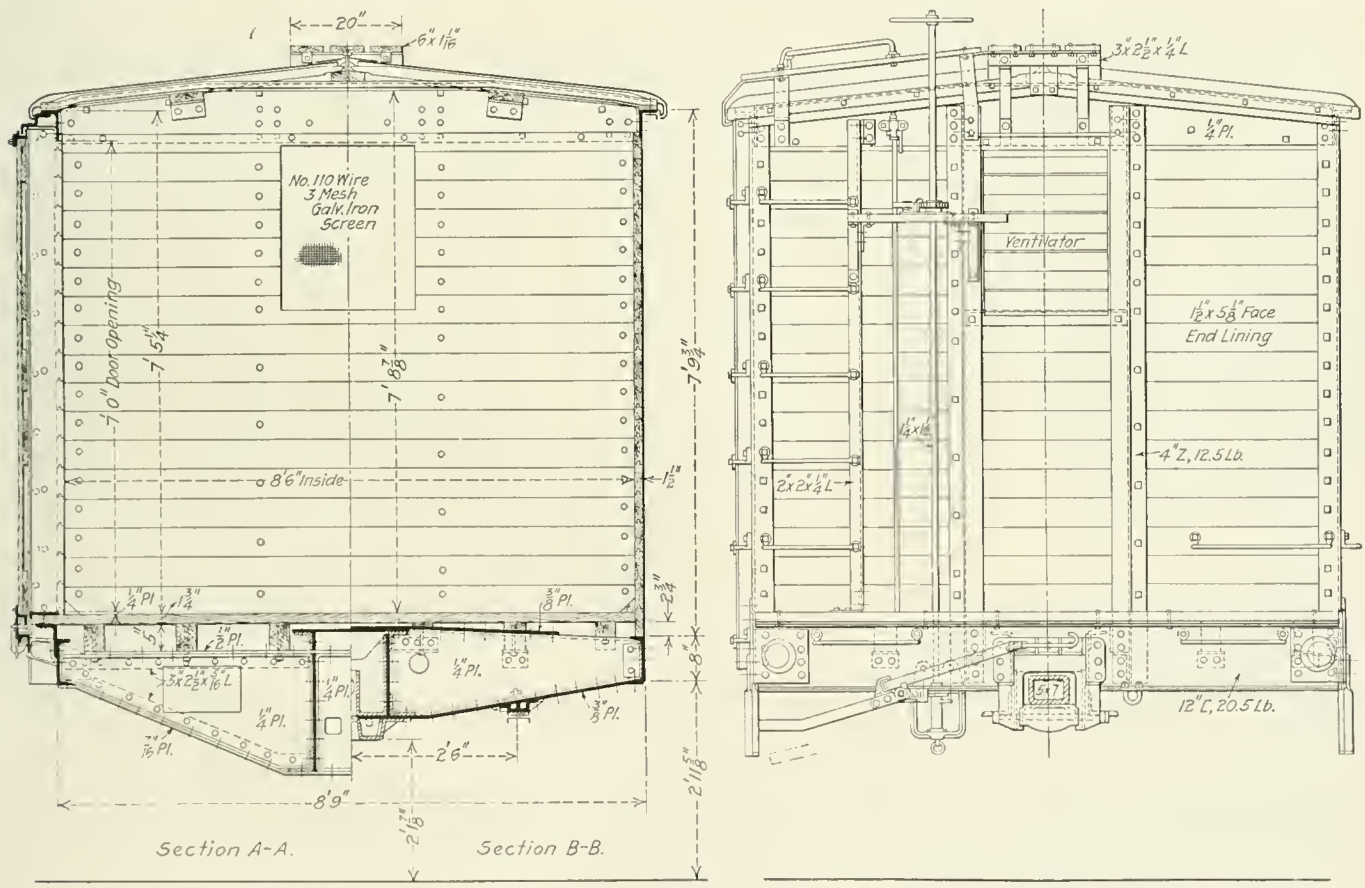
The lower end of the vertical shaft is also square in section and is tapered where it is inserted in the upper gear. To eliminate the necessity for precision in locating the gear casing with relation to the opening in the vestibule floor, this shaft is provided with a universal joint so that slight inaccuracies of alinement are taken care of without causing the parts to bind.

With the exception of the shafts, the parts of the device are all malleable castings and only such finish is provided for as is necessary to secure proper working alinement of the gears. The casing is made in three pieces, one of which is cast integral with the bracket by which the device is attached to the brake step. The gears are provided with finished hubs which have their bearings in reamed or drilled holes in the casing.

Box Cars for the Cuba Railroad

Forty Ton Capacity Single Sheathed Steel Frame Equipment of Exceptionally Strong Construction

Car equipment for foreign railways is usually of interest by reason of the divergence from American standards of design. However, the Cuba Railroad has recently put into service some box cars which in strength and general design compare favorably with similar types in this country. These cars were designed and built by the American Car & Foundry Company. The first lot was recently completed and an additional order is now under construction. The cars are of the single sheathed type with steel underframes and steel superstructure. The nominal capacity is 36,400 kilos, or 80,247 lb., and the length over the end sills is 38 ft. 0 in. The light weight is approximately 40,000 lb. The car body is 36 ft. 6⅞ in. long inside, the inside height and width being 7 ft. 5¼ in., and 8 ft. 6 in., respectively.



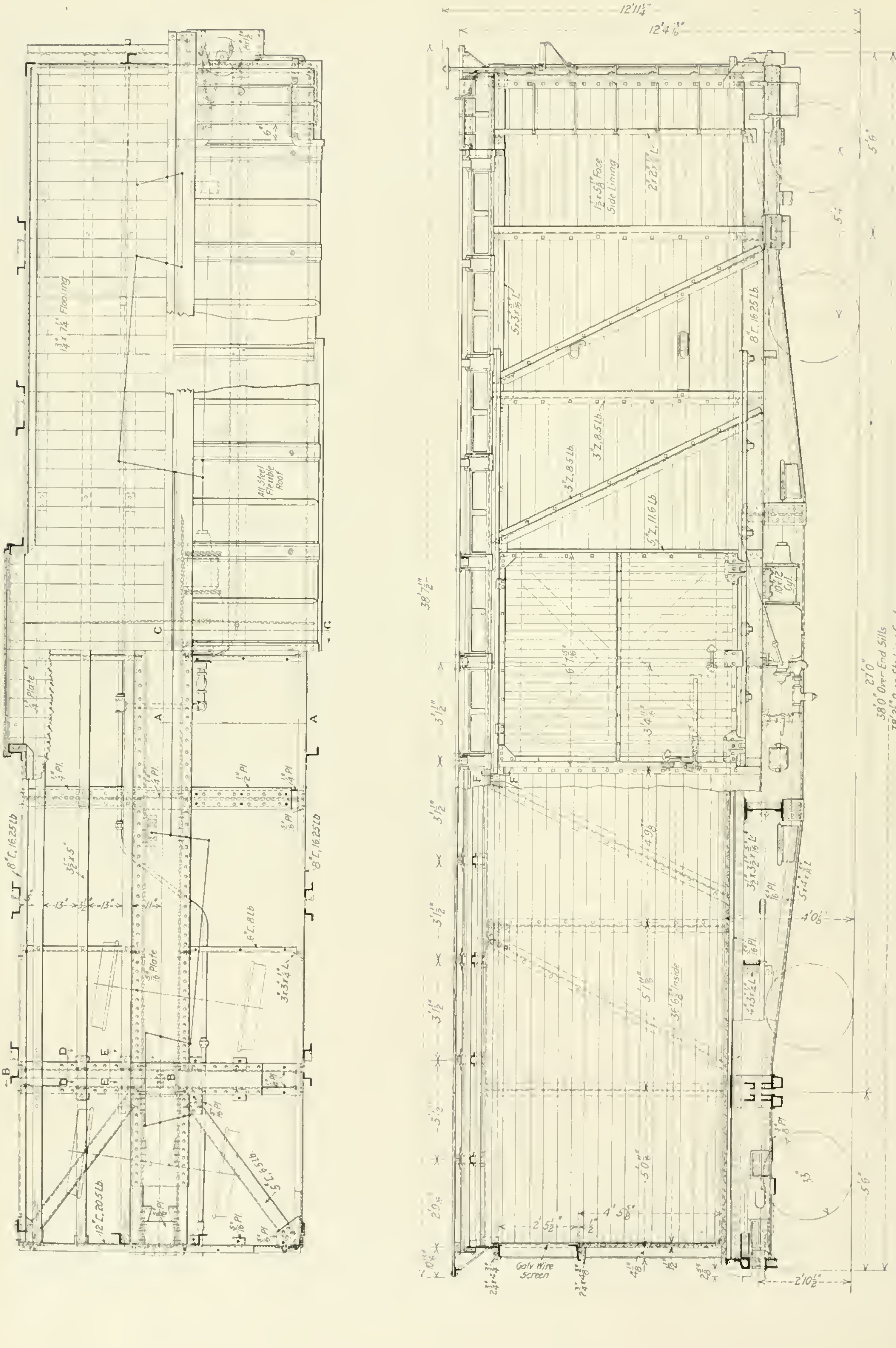
End Elevation and Sections of 40-Ton Box Car for Cuba Railroad.

Underframe

The underframe is built up of rolled shapes and plates, comparatively few pressed steel parts being used. The center sill is of the fishbelly type, consisting of two steel side numbers continuous between the end sills. They are made of 15/16-in. plates with top chords of 3½-in. by 3½-in. by 5/16-in. angles and bottom chords of 5-in. by 4-in. by ⅝-in. angles with the long flanges placed horizontally. The sills are 24¾ in. deep for a length of 10 ft. 4 in. at the center and taper to 15 in. deep just inside of the body bolsters. The web plates are reinforced vertically with 4-in. by 3-in. by ¼-in. angles. A steel top cover plate 5/16 in. thick and 21 in. wide is riveted over the greater portion of the center sill, extending to a point approximately over the center of the draft gear. The body bolsters consist of two ¼-in. pressed steel diaphragms with 3-in. flanges all around, spaced six inches apart. Each bolster is reinforced at the top by a 12-in. by ⅜-in. cover plate, extending a short distance beyond the side bearings, and at the bottom by a 13-in. by ⅜-in. plate, extending the full width of the car. The bolsters have cast steel center plates and center fillers and malleable iron side bearings. The top of the bolster slopes downward from the center sill and the top of the side sill is 1⅜-in. lower than the top of the center sill. The side sill is of 8-in. 16¼-lb. channel section and extends continuously from end sill to end sill.

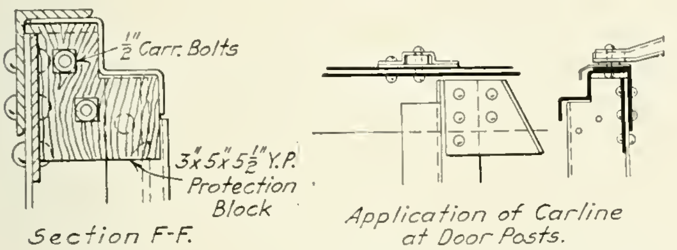
There are two crossbearers, spaced 9 ft. 3½ in. apart. Each consists of a ¼-in. pressed open hearth steel diaphragm, flanged three inches wide on all sides. A filler of similar construction is placed between the center sills. The crossbearer is reinforced at the top and bottom with a 3-in. by 2½-in. by 5/16-in. rolled steel angle. The top cover plate is 8 in. by ½ in. and extends through the center sill web plates. The bottom cover plate is 8 in. by 7/16 in. and extends continuously from side sill to side sill, passing under the center sill.

At the center of the car and midway between the body bolsters and crossbearers there are floor beams consisting of 6-in., 8-lb. channels, secured to the side and center sills by



Plan and Elevation of Box Car for Cuba Railroad.

means of the vertical stiffening angles, and also by pressed angle connections, as shown in the sectional drawing. The end sills are 12-in., 20½-lb. channels and extend straight along the full section for the entire width of the car. A 5-in., 6½-lb. channel extends from the corner of the body bolster and center sill to the corner of the car, where it is attached to the side sill and end sill by means of flanged gusset plates. The draft gear is of the Cardwell friction type with Sharon

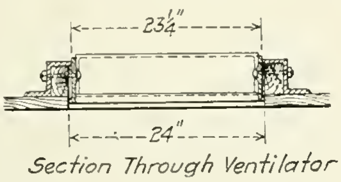


Side Plate Section at Floor and Arrangement of Roof Members

couplers operated by the American Car & Foundry Company's direct-connected top operating uncoupling device.

Superstructure

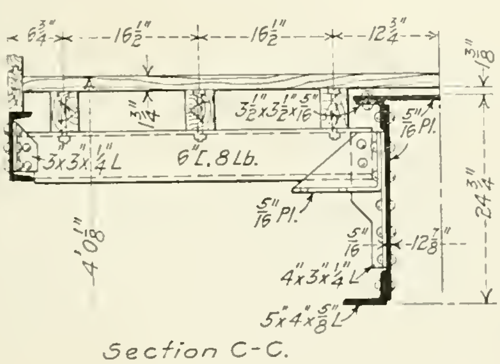
Both the vertical and horizontal intermediate members of the side truss are 3-in., 8½-lb. Z-bars, securely riveted to the side sill and to the side plate, which is a 5-in. by 3-in. by 5/16-in. angle with the short flange extending outward.



Section of End at Ventilator

The door posts are 5-in., 11.6-lb. Z-bars. A pressed steel section attached to the flange of the side plate serves as reinforcement over the door opening and also as weather protection for the door. The side sill is reinforced under the door opening by a 5¾-in. by 3¾-in. by 5/16-in. bent angle.

The corner posts are 5-in. by 4-in. by ⅜-in. rolled steel angles and are secured to the side sill by means of bent angle clips. At the upper end they are riveted to the side plate

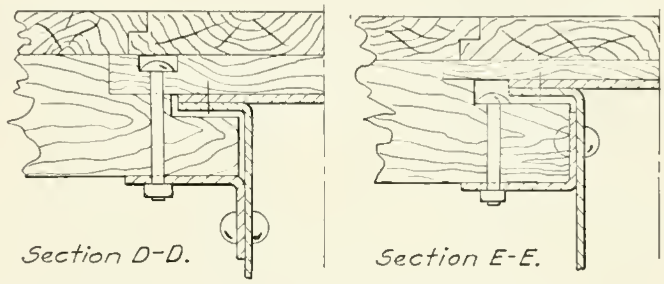


Section at Crossbearer

and the end plate, which is of ¼-in. steel plate, shaped to suit the roof. There are two Z-bar end posts of 4-in. 12½-lb. section. Between the end posts, directly below the running board brackets, is placed a Wine shutter type ventilator. The steel car lines are riveted directly to the side plate.

The side lining is 1½-in. by 5⅛-in. tongued and grooved yellow pine bolted to the steel frame. Floor stringers of 5-in. by 3½-in. yellow pine are applied over the floor beams and crossbearers, extending continuously between the end sills, the sections at the bolsters being arranged as shown in the drawing. There are three stringers on each side of the car and to them is secured the flooring, which is 1¾-in. by 7¼-in. yellow pine, ship lapped. Two and one-quarter inch beveled grain strips are applied at the sides and ends.

The side doors, which have a clear opening of six feet,



Arrangement of Stringers and Flooring at Bolster

are constructed of 13/16-in. yellow pine, tongued and grooved, with a 13/16-in. pine frame. The outside frame and crossbar are steel angles. The doors are fitted with Camel Company door fixtures, including bottom rollers, door starter and burglar-proof lock. Handholds, ladders and sill steps are all in compliance with the requirements of the federal safety appliance laws and the standards of the American Railroad Association.

Trucks

The trucks are of the rigid diamond arch bar type with 5-ft. 4-in. wheel base, having cast iron wheels and A. R. A. standard journal boxes. The bolsters are of cast steel with the center plate cast integral and are fitted with Stucki roller side bearings. The spring plank is pressed steel of channel section. Ajax No. 2 brake beams are used.

These cars were shipped on their own wheels, being sent to Key West over the Florida East Coast and transferred to Cuba on the car ferry operated by that road.

WHEN TO HEAT WOOD BEFORE GLUING*

Whether a hide glue joint will be strengthened or weakened by heating the wood before gluing depends on the size of the joint. If the joint to be made is of small area, heating the wood is unnecessary. In fact, it may be detrimental, for the warmth of the wood will keep the glue thin; and, when pressure is applied, too much glue may squeeze out, leaving a starved joint. It is easy to apply too much pressure.

In making glue joints of large size (several inches each way), heating the wood before gluing is of distinct advantage. Many experiments at the Forest Products Laboratory, Madison, Wis., have proved that when the wood in large joint work is not heated the joints develop full strength only in spots. Weak spots and even open joints are too frequently discovered. Uniform high strength in joints of large size may be secured by heating the wood in a hot-box for 10 or 15 minutes at 120 to 130 deg. F. just before gluing. The heat from the wood prevents the glue from chilling.

It should be remembered that heating the wood retards the setting of the glue to some extent. In heavy woods, from which the heat escapes slowly, this retarding effect is more marked than in lighter woods. In all species glued cold at the laboratory the time under pressure required to develop full joint strength was less than eight hours. When heated wood was used at least 10 hours were required to develop full joint strength in mahogany, and over 12 hours in oak and maple.

*Technical note No. 92, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

THE INSPECTION OF FREIGHT EQUIPMENT

Special Conditions Affecting the Loading of Cars and the Handling of Fast Freight Trains

BY L. K. SILLCOX

Assistant General Superintendent Motive Power, Chicago, Milwaukee & St. Paul

TO THE END that non-serviceable cars be kept off our line, car inspectors at interchange points will be careful to see that foreign cars coming from connecting lines are in good running order and otherwise fit for loading for which cars are intended.

When system cars are received in interchange with wrong repairs, car foremen will arrange for joint inspection being made and a joint evidence card being properly filled out and signed. This joint evidence card is to be forwarded to the master car builder's office with a bill, to cover correction of the wrong repairs. If the wrong repairs are not corrected at the time, the joint evidence card is to be securely tacked to outside face of the intermediate sill or on the cardboard on the center sill of all-steel cars. When wrong repairs are finally corrected the card may be removed and attached to a bill and forwarded immediately to the master car builder's office.

Cars Placed for Loading, Inspection and Repairs

It is of special importance that careful inspection be given and proper repairs made to cars before they are placed for loading to insure their being in good serviceable condition, as it should not be necessary to shop cars out under load before arriving at destination for defects that existed before being loaded. It is felt that no reasonable excuse can be given for placing a defective car for loading.

Light Repair Cars

When freight cars are shopped out for repairs, those needing the lighter repairs should be placed on repair tracks designated for such repairs so they will be promptly repaired and returned to service.

Marking Cars to the Repair Tracks Unnecessarily

In going over the railroad, it generally appears that at certain points insufficient attention is given light repairs to cars in yards. Many such cars when not handled in the yard are marked to the repair track, which is not only costly from a transportation standpoint, but also delays equipment and inflates the bad order statement.

It should be impressed upon all concerned that wherever possible, light repairs to cars should be made in yards and equipment ought not to be marked to the repair tracks for brake shoes, brake rods, packing, brasses, etc., when there is any possible way of doing this in the yard under blue flag protection.

When cars are shopped out by inspectors for minor repairs that can be made in transportation yards, the needed force should be provided so the cars can be promptly repaired, avoiding the necessity and cost of switching them to shop tracks.

The importance of this cannot be brought forcibly enough to the attention of all concerned. Certain stations show a sad lack of understanding in this direction. It should also be borne in mind that the journal box lids on freight trains must be opened at the principal inspection points, not only the lids on boxes that are easy to open, but also those that are more difficult. It means much to know whether the lubrication of the equipment is in fit condition and unless this precaution is taken there is bound to be continued difficulty.

Disposition of Unfit Cars

Instructions are issued giving automatic disposition and limit of expense for system owned freight cars. Unfit cars which come within the limits prescribed must be held for disposition as indicated and in order to show the true condition of affairs, the back of the No. 55 telegraph report is to contain the numbers and initials of foreign and system cars held for advice as to destruction or rebuilding. It is not economy to allow old unfit cars to continue in service causing good equipment to be damaged and broken up, and therefore these rules must be given the attention they deserve. Proper report of all cars destroyed or exchanged from one class to another must be made up as prescribed.

Shopping of System Freight Cars

It is not desired to ship bad order cars from one repair point to another, and no cars must be sent forward from one repair station to another without receiving written authority from the master car builder, assistant master car builder, or respective district general car forman's office. Violations of this rule will not be tolerated. Where bad order cars are sent from one station to another, they must be held on the originating station's bad order report, until such time as advice is received from the destination point, that they have received and will carry the cars. As a general rule, and in order to properly arrange material requirements, it is our practice to give preference to shipping system equipment in the following manner, concentrating on certain types to regularly meet the business:

January-February—Cabooses, Bunk Cars, Refrigerators.

March-April—Stock and Flour Cars.

May-June—Grain and Stock Cars.

July-August—Coal, Cinder and Merchandise Cars.

September-October—Logging. Flats and refrigerator Cars.

November-December—Ballast and Ore Cars.

Commodity Cards

The general practice of employing the use of commodity cards and boards is not wholly satisfactory unless very closely supervised. After cars have been loaded, these cards or boards should be removed as many suits for damage claims have been filed on the basis of information shown on rough freight cards or a leaky roof sign. Agents should be interested in giving this matter proper attention, also in removing explosive signs or cards when cars are emptied.

Obtaining Disposition of Foreign Equipment

It is intended that empty foreign cars in bad order on the railroad and which it is not considered advisable to repair, be written up for disposition promptly. Material required from owners for repairs to foreign cars on the railroad must be ordered just as quickly as possible so as not to hold cars unnecessarily. If action is not obtained within a 30 day period on either of the above items, and it causes any foreign car to be held in bad order more than 30 days, a telegram should be sent to the MCB office giving all particulars and data. If it happens to be that owners are dilatory the matter will be taken up with the executive of the owning line for immediate action. If cars stand around more than 30 days, let no effort be spared to get them moving.

Handling Charges for Repairing Foreign or Private Line Cars

Repairs of any kind to cars of foreign ownership, whether railroad, or privately owned, will be charged for in accordance with American Railroad Association rules, the latest price instructions to govern, all covered by the usual repair card. On cars of private ownership, or in cases where owners are not members of the association, charges will be made at actual cost and collection will be made by the agent, a complete record being kept and full advice sent to the master car builder in all cases so that proper accounting of these amounts may be insisted upon. In case repairs have to be made at any station where emergency trucks are not located, the necessary material will be obtained from the baggage car, or failing in this, such parts as desired can, if practical, be removed from the rear end of the rear car temporarily.

Transferring Bad Order Loads

Car foremen at all repair points will be considered the proper parties for authorizing the transfer of lading on any bad order car that cannot be repaired under load. Where additional help is required in order to carry out such transfer of lading, car foremen will take the matter up by wire, with the general car foreman or their immediate superior, stating necessity in detail. The higher officer in turn will request the superintendent to furnish the required number of men. This contemplates the entire abandonment of agents' forces or transferring being handled by contractors at any point on the system.

At the smaller stations, in case transferring is required on a valuable shipment, such as furniture, merchandise, machinery or finished and manufactured products, car foremen will call on the agent to break the seal and be in a position to verify that no unnecessary damage is done in the operation of transferring.

A weekly report of freight cars transferred or lading adjusted, must be made to the master car builder's office every Saturday night, and a copy sent to the general supervisor of transportation.

Line Clearance Diagram

The proper diagram should be posted at all inspection points for the instruction of inspectors, giving maximum clearance for loading which should be regarded with reference to offering cars in interchange at connecting points, also at originating points of loading. There has been a great deal of difficulty on account of being obliged to transfer loads on account of equipment not having proper clearance.

The car department must co-operate with agents on the system to the extent of cautioning them not to accept shipments wherein the clearance exceeds that stated. Agents will be able to check this matter to their own satisfaction, inasmuch as they are informed as to routing and billing.

All car foremen should co-operate to avoid having to transfer cars at connections on account of the limitations called for being exceeded and all should interest themselves in this matter. In case of doubt, the maximum clearance to pass all lines is a height of 12 ft. 6 in. and a width of 9 ft. 6 in., but most lines have a maximum height clearance of about 15 ft. and a width of 10 ft. 3 in.

Height to Load Grain in Cars

The following data have been worked up to show the maximum height to which a car may be loaded with grain depending on its inside length and width, based on the following weights:

Grain.	Weight per Bushel, lb.
Wheat	60
Corn, rye or flax	56
Barley	48
Oats	32

30 Ton Capacity Cars 8 ft. 6 in. Wide Inside

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
31 ft. 0 in.	4 ft. 9 in.	5 ft. 1 in.	6 ft. 0 in.	8 ft. 0 in.
32 ft. 0 in.	4 ft. 7 in.	4 ft. 11 in.	5 ft. 9 in.	8 ft. 7 in.
33 ft. 0 in.	4 ft. 8 in.	4 ft. 9 in.	5 ft. 7 in.	8 ft. 4 in.
34 ft. 0 in.	4 ft. 4 in.	4 ft. 8 in.	5 ft. 5 in.	8 ft. 1 in.
35 ft. 0 in.	4 ft. 2 in.	4 ft. 8 in.	5 ft. 3 in.	7 ft. 10 in.
36 ft. 0 in.	4 ft. 1 in.	4 ft. 5 in.	5 ft. 1 in.	7 ft. 8 in.
37 ft. 0 in.	4 ft. 0 in.	4 ft. 3 in.	4 ft. 11 in.	7 ft. 5 in.
38 ft. 0 in.	3 ft. 11 in.	4 ft. 1 in.	4 ft. 10 in.	7 ft. 3 in.
39 ft. 0 in.	3 ft. 10 in.	4 ft. 0 in.	4 ft. 8 in.	7 ft. 1 in.
40 ft. 0 in.	3 ft. 8 in.	3 ft. 11 in.	4 ft. 7 in.	6 ft. 9 in.
41 ft. 0 in.	3 ft. 7 in.	3 ft. 10 in.	4 ft. 5 in.	6 ft. 7 in.
42 ft. 0 in.	3 ft. 8 in.	3 ft. 9 in.	4 ft. 4 in.	6 ft. 6 in.

40-ton Capacity Cars 8 Ft. 8 In. Wide Inside

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
36 ft. 0 in.	5 ft. 5 in.	5 ft. 9 in.	6 ft. 9 in.	10 ft. 2 in.
37 ft. 0 in.	5 ft. 5 in.	5 ft. 9 in.	6 ft. 9 in.	10 ft. 2 in.
38 ft. 0 in.	5 ft. 1 in.	5 ft. 6 in.	6 ft. 5 in.	9 ft. 8 in.
39 ft. 0 in.	5 ft 0 in.	5 ft. 4 in.	6 ft. 3 in.	9 ft. 5 in.
40 ft. 0 in.	4 ft. 11 in.	5 ft. 3 in.	6 ft. 1 in.	9 ft. 1 in.
41 ft. 0 in.	4 ft. 10 in.	5 ft. 1 in.	6 ft. 0 in.	9 ft. 0 in.
42 ft. 0 in.	4 ft. 9 in.	5 ft. 0 in.	5 ft. 10 in.	8 ft. 9 in.
43 ft. 0 in.	4 ft. 8 in.	4 ft. 10 in.	5 ft. 9 in.	8 ft. 7 in.
44 ft. 0 in.	4 ft. 7 in.	4 ft. 9 in.	5 ft. 7 in.	8 ft. 5 in.
45 ft. 0 in.	4 ft. 4 in.	4 ft. 8 in.	5 ft. 5 in.	8 ft. 3 in.
46 ft. 0 in.	4 ft 3 in.	4 ft. 7 in.	5 ft. 3 in.	8 ft. 0 in.
47 ft. 0 in.	4 ft. 1 in.	4 ft. 6 in.	5 ft. 2 in.	7 ft. 10 in.

40-Ton Cars 8 Ft. 2 In. Inside

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
38 ft. 0 in.	5 ft. 3 in.	5 ft. 9 in.	6 ft. 7 in.	8 ft. 10 in.
37 ft. 0 in.	5 ft. 1 in.	5 ft. 6 in.	6 ft. 5 in.	9 ft. 7 in.
38 ft. 0 in.	5 ft. 0 in.	5 ft. 4 in.	8 ft. 3 in.	9 ft. 5 in.
39 ft. 0 in.	4 ft. 11 in.	5 ft. 9 in.	8 ft. 1 in.	9 ft. 3 in.
40 ft. 0 in.	4 ft. 9 in.	5 ft. 1 in.	5 ft. 11 in.	9 ft. 0 in.
41 ft. 0 in.	4 ft. 8 in.	4 ft. 11 in	5 ft. 10 in.	8 ft. 10 in.
42 ft. 0 in.	4 ft. 6 in.	4 ft. 10 in.	5 ft. 8 in.	8 ft. 8 in.
43 ft. 0 in.	4 ft. 5 in.	4 ft. 8 in.	5 ft. 7 in.	8 ft. 6 in.
44 ft. 0 in.	4 ft. 4 in.	4 ft. 7 in.	5 ft. 5 in.	8 ft. 4 in.
45 ft. 0 in.	4 ft. 3 in.	4 ft. 6 in.	5 ft. 4 in.	8 ft. 1 in.
46 ft 0 in.	4 ft. 2 in.	4 ft. 5 in.	5 ft. 3 in.	7 ft. 10 in.
47 ft. 0 in.	4 ft. 1 in.	4 ft. 4 in.	5 ft. 1 in.	7 ft. 7 in.

50-Ton Cars— 8 Ft. 6 In. Wide Inside

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
36 ft. 0 in.	6 ft. 9 in.	7 ft. 3 in.	8 ft. 6 in.	12 ft. 8 in.
37 ft. 0 in.	8 ft. 7 in.	7 ft. 0 in.	8 ft. 2 in.	12 ft. 5 in.
38 ft. 0 in.	6 ft. 6 in.	6 ft. 11 in.	7 ft. 11 in.	12 ft. 2 in.
38 ft. 0 in.	6 ft. 3 in.	6 ft. 9 in.	7 ft. 9 in.	11 ft. 10 in.
40 ft. 0 in.	6 ft. 1 in.	6 ft. 7 in.	7 ft. 7 in.	11 ft. 6 in.
41 ft. 0 in.	6 ft. 0 in.	6 ft. 6 in.	7 ft. 6 in.	11 ft. 4 in.
42 ft. 2 in.	6 ft. 10 in.	6 ft. 5 in.	7 ft. 5 in.	11 ft. 1 in.
43 ft. 0 in.	5 ft. 9 in.	6 ft. 3 in.	7 ft. 4 in.	10 ft. 8 in.
44 ft. 0 in.	5 ft. 7 in.	8 ft. 1 in.	7 ft. 2 in.	10 ft. 4 in.
45 ft. 0 in.	5 ft. 5 in.	5 ft. 11 in.	7 ft. 0 in.	10 ft. 1 in.
46 ft. 0 in.	5 ft. 3 in.	5 ft. 9 in.	8 ft. 11 in.	9 ft. 11 in.
47 ft. 0 in.	5 ft. 2 in.	5 ft. 7 in.	8 ft. 10 in.	9 ft. 9 in.

50-Ton Cars 8 Ft. 9 In. Wide Inside.

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
38 ft 0 in.	6 ft. 7 in.	7 ft. 1 in.	8 ft. 3 in.	12 ft. 6 in.

50-Ton Cars, 8 Ft. 9 In. Wide Inside

Length inside	Wheat	Corn, Rye or Flax	Barley	Oats
37 ft. 0 in.	6 ft. 5 in.	8 ft. 11 in.	8 ft. 1 in.	12 ft. 3 in.
38 ft. 0 in.	6 ft. 3 in.	6 ft. 9 in.	7 ft. 11 in.	12 ft. 0 in.
39 ft. 0 in.	6 ft. 1 in.	6 ft. 7 in.	7 ft. 8 in.	11 ft. 6 in.
40 ft. 0 in.	5 ft. 11 in.	6 ft. 4 in.	7 ft. 5 in.	11 ft. 1 in.
41 ft. 0 in.	5 ft. 9 in.	6 ft. 2 in.	7 ft. 2 in.	10 ft. 7 in.
42 ft. 0 in.	5 ft. 7 in.	6 ft. 0 in.	6 ft. 11 in.	10 ft. 3 in.
43 ft. 0 in.	5 ft. 5 in.	5 ft. 10 in.	6 ft. 9 in.	10 ft. 1 in.
44 ft. 0 in.	5 ft. 4 in.	5 ft. 8 in.	6 ft. 7 in.	10 ft. 0 in.
45 ft. 0 in.	5 ft. 3 in.	5 ft. 7 in.	6 ft. 6 in.	9 ft. 11 in.
46 ft. 0 in.	5 ft. 2 in.	5 ft. 6 in.	6 ft. 6 in.	9 ft. 9 in.
47 ft. 0 in.	5 ft. 1 in.	5 ft. 5 in.	6 ft. 4 in.	9 ft. 8 in.

Loading of Lumber on Open Top Cars

In the past there has been considerable trouble caused by carloads of lumber on flat and coal cars shifting, losing part of the load and making it necessary to set cars out to be re-staked and given considerable attention. This should be brought to the notice of agents and shippers should be advised that the M. C. B. rules governing the loading of lumber, piling, etc., on open top cars, must be carefully observed and cars must not be allowed to be forwarded in an unsafe condition. Stakes and wiring must be carefully examined and all precautions taken to see that there are enough of the stakes and that they are sufficiently strong to carry the load safely.

Inspectors must watch these shipments carefully and not allow a load to go forward until it is safe, and where one is found to be unsafe, it must be attended to properly, and a record taken as to where it was loaded and its destination, stating whether the staking, etc., is deficient so that the matter may be corrected at the initial loading point.

Bearing pieces, especially on wooden flat cars, must be placed over the bolsters, otherwise breakage of sills is bound to result.

Handling Gravel Ballast Cars

It is well to remember that open top cars loaded with sand and gravel become greatly overloaded in periods of rainy

weather. It has been determined that sometimes as much as 6,000 lb. additional load is encountered due to moisture absorbed and on this account all concerned are asked to guard in every reasonable way against overloading cars when such conditions prevail. System owned high side 50 ton gondolas are not to be used in gravel or ballast service, as they are not of suitable or strong enough construction.

Loading Ice in Refrigerator Cars

It should be thoroughly understood that in loading ice, refrigerator cars equipped with ice boxes must not be used in this traffic, owing to the damage resulting in the interior of the car.

Classification of Trains

A train may consist of an engine, or motor, or more than one engine, or motor, coupled with or without cars displaying markers.

A regular train is one authorized by a time-table schedule.

A section of a train obtains when running one or two or more trains on the same schedule, displaying signals, or for which signals are displayed.

An *extra train* is one not authorized by a time table schedule. It may be designated as—*Extra* for any extra train, except work extra; *Work Extra*—for work train extra.

There is in general a broad classification of trains constituting first class, which are passenger, second class, which are time freights, and third class, which are way freights. All extra trains and those for work service fall into their proper classification automatically.

Time Freight Runs

The success of a road as a freight-carrying line depends almost entirely on its reputation and ability to keep time freights close to their schedule. With this end in view, their movements have been specially plotted, showing the stopping points and standard classes of inspection required. Much depends on the careful planning of all men along the line, for there is hardly a single town of any size on the system which does not receive and supply loaded cars entering into the movement of time freight trains. It is only natural to suppose that the operating department are very anxious at all times to get these trains out of town and on their way with as little delay as possible. Foremen will be held responsible for seeing that cars are properly repaired at loading platforms, industries, etc., bad ordering such cars exhibiting serious defects and which cannot be fixed up in time to let them out for movement as intended on this account. Foremen should make such arrangements as to see that these cars when discovered are not loaded out, but sent empty to the repair track for attention. It is not a difficult matter to anticipate the movement of loads coming from connections, which are to form part of important time freight runs. Many times the shipment reaches us with a lot of delay, which must somehow be wiped out and shippers keep wiring us for delivery. All that we can do is to see that prompt businesslike attention is accorded. It is often very aggravating to have large parts of important trains turned over from connections requiring wheel renewals, repairs to air brake equipment, defective trucks and draft rigging. Some of this is due to rough handling through large terminals, or it may be that weak equipment has been employed. No loaded cars for important movement are allowed to proceed from gateway terminals, unless the following requirements are met, with this exception, that short draft timber cars, if loaded, may be placed to the number of ten per train ahead of the caboose. (A) If draft timbers are used they must extend at least 30 in. behind the center of the bolsters. (B) Cars having steel center sills running from end to end of car are satisfactory. (C) Cars of steel underframe, steel frames or all metal construction are satisfactory. (D) Cars having short draft timbers in front of body bolsters must have the load transferred at gateway terminals and, if possible, the car is to be disposed of to the delivering line in a satisfactory manner, unless it is known that the car can be kept not more than ten cars ahead of the caboose, for the entire movement.

Too much cannot be said with respect to the importance of small repair stations along the line, watching diligently to see that unfit cars or equipment which has not received adequate attention are put in proper shape before being placed in important time freight trains. If the cars cannot be made suitable for the movement, they should not be released until the load is transferred, in the regular manner, as has been described.

Steel Trains, Silk Runs and Other Trans-Continental Movements

It often happens that there are special runs lasting for long periods, of commodities destined for export at the Pacific Coast, or imports coming from the Orient, Alaska and other parts of the world, or of similar character on other railroads than those operating in the northwest. These shipments are only maintained on our railroad to the extent of our being able to render better service than our neighbors. The secret of success in handling of such movements is to first know the characteristics and requirements of the service and to put the equipment in proper condition to start with so that it can make a successful run to its destination without a lot of delay intermediately due to defects which should have been previously discovered.

Logging, Lumber, Ice and Ore Trains

This type of train movement is more or less localized and yet important, in maintaining the good will, and necessarily the patronage, of the communities served. The requirements of service at the various points on the system are well known to local foreman. An active effort is absolutely essential and must be made at all times to keep the equipment in good shape to handle the business offered and avoid delays and disaster. Equipment in such service must be given periodical attention.

Meat, Fruit, Produce and Dairy Trains

Possibly the greatest problem in the movement of scheduled freight runs comes under these classifications. In the first place, the equipment going to make up these trains, makes more mileage than any other type, as it is kept in constant service; and this has a very definite effect on the ability of truck frames, wheels, and axles to withstand breakage due to fatigue of metal and crystallization. Boxes run hot due to the high speed maintained and the rocking load, especially in beef cars which, coupled with heavy superstructures, imposes tremendous strains on the running gear. The greatest possible temptation prevails to absorb lost time, often with disastrous results, for most of the shipments are of very perishable nature, and time is consumed not only in icing the equipment, but, in routes from California to New York in fruit runs, it is reasonable to suppose that many unforeseen conditions have to be met, not only operating, but mechanical and climatic. Experience has dictated a policy of starting the trains out in the best possible condition and all necessary repairs to be made at intermediate points, also where time is not allowed to give proper attention to defects, good judgment would dictate the cutting out of the car—and this must be done rather than take any chances. A careful check must be made to see that equipment in this service is not overlooked. The greatest pride should be centered in handling this difficult class of business promptly, successfully and safely. Wherever it can be arranged, cars must be gone over before being set for loading or at the time loading is going on.

Stock Trains

Certain sections of the railroad depend entirely, or, in a large part, on the ability to attract stockmen to ship over the line. Very certain and difficult competition has to be met. Besides this, one of the greatest opportunities offered for damage claims is accounted for from delay in getting stock to market on time, resulting in changing prices offered for stock at the primary markets, also delays mean extra feeds which burden the shipper with unwarranted expense. Defective equipment offered for loading should always be avoided, as there is plenty of time to fix stock cars properly during the idle season and at feeding stations, where they must necessarily lay five hours at least. This is a branch of the trade where we must deliver service, as the shipper has his representative on board to check up the movement.

The Federal law prohibits the movement of stock when such movement exceeds 36 hours, unless stock is unloaded for rest and feeding. It is therefore of the utmost importance that stock cars be given the best attention at originating stations and at feeding stations, so that the trains will be able to make their next stop without being delayed on account of defective equipment. The minimum layover at feeding stations is five hours.

Movement of stock trains is checked by government representatives, and in cases where the 36 hour law is violated, suits are brought against the road.

Primary movements will find their way to the stations, where the principal packing houses are located. Local car foremen are well acquainted with the necessities of the cars and must not only take into account movements which come to them from their neighboring foremen, but should take sufficient interest to see that when cars are returned they go into the loading territories in good order. In this sense the foremen can control their bad order situation and difficulties of movement through their territory to a very great extent. Too many foremen complain about their neighbors when they themselves had the same empty stock cars passing through their stations prior to being loaded and prior to returning to them in unfit condition under revenue load and allowed the cars to pass through their hands in defective condition and return in the same shape, necessitating delay to trains and oftentimes transfer of shipments. Further emphasis is necessary to point out that at feeding stations the minimum time allowed is five hours and the time between feeding stations is very much limited, due to shippers being unwilling to delay their stock and to go to the additional expense of extra feeds, which can be overcome if these trains are put in shape during the five hours allowed during the rest period. This must be done, and feeding stations are primarily responsible for the 36 hour movement of trains between feeding stations and consuming markets.

Work Trains

Proper co-operation and understanding with the operating department will do ever so much in providing for successful operation of work, gravel and ballast trains. Sufficient notice should be given in advance, so that opportunity may be taken to put cars in shape. Care should be exercised to be certain that the proper type of car is furnished; for instance, ballast cars should not be used where flat cars are wanted, resulting in the sides of ballast cars being torn off and wrecked, as has been done often in the past. Center plates should be well lubricated, side bearings free of each other, draft gear, brake and wheels in good order and lubrication, packing, brasses, wedges, boxes, covers and dust guards in perfect condition to render effective service. Overloading of cars is to be avoided.

Inspection of Trains

It is the duty of inspectors to see that the coupling pipe joints and all other parts of the brake apparatus are in good order and free from leaks. For this purpose they must be tested at every opportunity and especially when air pressure is available. If a defect is discovered in the brake equipment of a car which cannot be held long enough to give time to correct such defect, the brake must be cut out and the car properly carded to call the attention of the next inspector to the repairs required, but, as stated elsewhere, the carding of this brake must be the last resort and every effort should be made to repair the defect before the car is allowed to proceed.

The smallest proportion of freight cars with the air brakes in good condition must be 85 per cent. In making up trains the couplings must be united and the cocks at the ends of the cars all open, except at the rear end of the last car, where the cock must be closed. The inspector must know that the air is passing through the pipes to the rear end and that the couplings are properly connected and free from leaks. After the train is fully charged, the engineer must be signalled to apply the brakes. When the brakes have been applied, they must be examined upon each car to see that they are applied and have the proper piston travel. This having been ascertained, the inspector must signal the engineer to release the brakes. He must then again examine the brakes upon each car to note that each is released. If any defect is discovered, it must be corrected and the testing of the brakes repeated until they are found to work properly. The inspector must then enter on form 975 the number of cars with brakes in good order. This examination must be repeated if any change is made in the make-up of the train before starting.

Inspectors should especially take advantage of the incoming freight terminal test as this is the logical time to locate the defects as they will then have ample time to repair them. When the engineer applies the brakes and then cuts off, the inspectors must make a rapid inspection of piston travel, marking on the side of the car with chalk those cars which have either short or long travel, but not stopping to adjust the brakes or make any other repairs at this time, making all necessary adjustments on the way back. In many yards where a train is made up the outgoing engine is not coupled on until the time of departure. When this occurs everyone is in great haste to get this train out of the yard and in many cases the air brake inspection is neglected, but this can be overcome to a great extent if after a train is made up and the switching is all done, air from a switch engine is secured to charge up this train. If this is done, when the outgoing engine is coupled on, there will be nothing else to be done but to charge up the brakes and then leave.

Train Release Inspection Certificate

The object of this form is to guarantee the proper inspection and safe condition of the equipment and to obtain the benefit of the train crews' experience with the trains while on the road. Any defects shown on this form must be properly corrected and the car inspector at the inbound station is to make certain that ample assistance is provided to correct any of the defects reported by the conductor on this form so that it will not be necessary for him in filling out this form for the outbound movement of the train to include any of the defects previously reported. This form is to be made out in duplicate, and the car inspector will hand the conductor in charge of the train leaving the station two blanks with carbon paper between, all placed on a suitable board and of same dimensions as the report and held in place by a rubber band near the top. On arrival of the train at the inbound station, the car inspector will meet the conductor and receive Form 975 and will note thereon the number of brakes cut-out and sign the report in the space provided for inbound movement signature. He will at this time note whether the brakes cut-out have air

brake defect cards attached. He will also look over the report to see whether the conductor has reported any difficulty with the train while in his possession and if any trouble is reported it must be corrected immediately. The original of the report must then be forwarded to the division superintendent and the duplicate retained by the local car foreman in charge of the station at which the train arrives. These copies must be kept in neat order so as to be readily accessible in the event it is desired to look up the record on any train arriving at the station. It should be understood that these reports are to be used on all divisions and are to cover the operation of a train from one terminal to the next terminal and where a train goes through several terminals, the car inspector will arrange to supply new forms to the conductor taking charge of train leaving station. In other words, the one form is not to be carried through from the originating station to the final terminal, but is to be carried only so far as each divisional terminal where train crews change.

Carding Cut-Out Brakes

The applying of air brake defect cards to cars on outgoing trains by inspectors must be the last resort. The necessary repairs must and can be made if the inspection is made at the proper time, i.e., on the arrival of trains. This defect card is primarily for the use of trainmen who oftentimes encounter a brake, while en route, that is causing them trouble and their only resource is to cut this brake out to enable them to get over the road. In order to expedite all repairs on this brake, they are furnished with an air brake defect card which they should attach to the crossover pipe, marking on this card the reason why the brake was cut out. On arrival at the terminal the inspectors and repair men must make every effort to repair the defect as carded. The only time when an inspector will be permitted to allow a car to proceed with the brake cut out and a defect card attached will be when under no circumstances could this car be held to make the necessary repairs, such as in manifest freight service. Cars arriving in yards with brakes cut-out and no cards attached should be reported to the foreman in charge who in turn will take this matter up with the division superintendent as it is imperative that anyone cutting out a brake for any reason whatever should apply an air brake defect card properly filled out as to the defect for which it was cut out.

Hot Boxes on Incoming Trains

As a general rule, car equipment coming in on time freights, or otherwise, having hot boxes, should be given immediate attention to avoid the entire destruction of the packing, dust guards and journal, due to continued burning of the waste. Under these circumstances, the packing should be removed immediately when discovered and the journal jacked up and allowed to cool so that the work can be done on the train while the box is cooling off and inspectors return and finish the job without having to switch cars out. It very often happens that cars are marked out for cut jurnals under these circumstances, when this is not a fact, and a large saving in expense can be obtained through diligent following up of the work along the lines described. All packing when pulled out should be placed in a suitable pail or metal receptacle and not thrown on the ground.

Method of Treating Hot Boxes En Route

In stating the method of treating hot boxes enroute, for the information of train crews, the following should be remembered: As prepared packing and tools are assigned as a part of the train equipment, they should consist of a standard bucket, packing iron and hook. Trainmen should see that the packing is protected from dirt and water.

It should be the duty of the trainmen when taking cars at points where there are no car inspectors to examine the journal boxes and see that they are in proper condition for safe movement. A little time and attention may save the annoyance of a hot box and serious detention to the train.

When there is evidence of a journal heating, open the box lid, insert the packing hook along the journal to ascertain if the packing is in contact with the journal for its entire length and that the journal is not cut. If the packing is not in contact with the journal and the journal is not cut, add fresh packing, if necessary, or raise the packing in the box, so that it may have proper contact with the journal. If it continues to heat, a new brass should be applied.

In applying a new brass, first remove the packing from the box, placing it in a bucket, or in some other manner protecting it so that it will not come in contact with the ground; then jack up the box. Frequently, when jacking up the box, the wheels will rise from the rail, holding the brass and wedge against the crown of the box. A block placed from the top of the wheel to the sill of the car will prevent this. When the brass and wedge are free from weight, insert the packing tool along each side of the brass and pull the brass and wedge forward out of the box; this to keep the brass from turning to the underside of the journal and dropping to the bottom of the box. Packing removed from the journal and not used in the repacking of the box should be returned to the point designated by official order on the respective divisions.

When water is used for cooling, the journal should not be cooled to a low temperature and water should not be used until the brass has been renewed. Notice should be given at the end of the run at the point of cut-out, if the car is cut-out, that the journal has been cooled by water, in order that it may be removed at the first opportunity.

Carefully examine the journal with the packing hook to determine rough or cut places. The condition of the journal should be mentioned on the report of hot boxes. Before applying a brass, place the wedge on it and note that the wedge rests on the crown of the brass with some clearance on the sides.

To determine the fit of a journal, cover the surface of the brass with a thin coating of oil, which should be squeezed from the packing, and place the brass on the journal, moving it back and forth a few times. Then remove it carefully and if the face shows that it bears on the edges of the brass, the brass is too small in radius, which would cause it to heat. If the brass bears along the crown for its whole length and from 1½ to 2 in. in width and clear of contact at the edges, it is of proper size. The face of the brass should be oiled before applying, by squeezing oil from the packing.

Apply the wedge on top of the brass after the brass has been placed on the journal and be sure that the wedge is back in proper position and not resting on the lugs which hold it in position in the crown of the journal box. In lowering the journal box, be sure that the wedge and brass are properly seated.

If the car having a hot box is set off at a siding, or brought into a terminal, the box should be plainly marked by the trainmen in the absence of an inspector. This mark must remain thereon until removed by the car inspector or repairer after the box has been properly cared for. A box thus marked will indicate to the car inspector or repairer that it has given trouble on account of heating and requires attention.

Lignite Briquettes, manufactured from natural coal tar and lignite from Alberta, Canada, coal mines, will probably be placed on the market before another year. Government experts are working on a solution to extract tar from the extensive sands of Alberta, with a view to using it in the manufacture of briquettes.—*The Engineer, London.*

EXPERIMENTS WITH LATHE TURNING TOOLS

In a paper recently presented before the Institution of Mechanical Engineers George W. Burley described a series of experiments covering certain points relating to the cutting qualities and efficiency of lathe turning tools made in the machine tool laboratory of the University of Sheffield. As a result of these experiments the following conclusions were reached:

1. There is no practical cutting speed below which it is impossible to obtain a satisfactory surface on plain carbon steels by means of ordinary lathe finishing tools, whether these be made of plain carbon tool steel, ordinary (non-vanadium) high speed steel, or superior (vanadium) high speed steel. There is, however, a maximum limiting speed above which a satisfactory finish cannot be obtained on account of the tendency of the tool to pluck at and tear the surface, this tendency being related to the phenomenon of building up on the cutting edge of the tool. For the finishing of mild steel this limit is not very different for each of the above three varieties of tool steel and is within the range of 48 to 58 ft. per minute. For the finishing of hard steel this limit does depend somewhat on the variety of tool steel which is employed and is within the ranges of 23 to 28, 17 to 21, and 28 to 34 ft. per minute for the three varieties of tool steel respectively.

2. The durability or life of a lathe finishing tool, whether of plain carbon or high speed steel, is for all cutting speeds below the limiting speed some function of the reciprocal of the cutting speed; in other words, an increase in the cutting speed below the limiting value is always accompanied by a decrease in the life or durability of the tool.

3. The most suitable angle of side rake (that is, the angle of side rake associated with maximum durability and cutting power) for a high speed lathe roughing tool working on steel depends upon the physical properties of the steel. For mild steel turning it lies between 20 deg. and 25 deg., while for hard steel turning it is of the order of 10 deg.; and if these angles are either increased or reduced there is always a depreciation of cutting power.

4. The color of the turnings formed by a high speed lathe roughing tool when working on steel is not necessarily a true index of the condition of maximum cutting efficiency. Thus, in the case of hard steel turning, the turning color which is associated with maximum cutting efficiency is a pale blue, while a mild steel turning which is removed under the conditions of maximum efficiency is practically uncolored, apart, of course, from the natural gray color of the steel.

5. The net power consumption of a high speed roughing tool is dependent, other conditions being constant, upon the amount of top rake on the tool, the relation between these two quantities being reciprocal in character, so that, within the limits of ordinary practice, a reduction in the top rake angles of a tool is always accompanied by an increase in the net amount of power consumed. The law connecting the variations of the two quantities appears to be of the nature of a straight line law for all qualities of steel machined. There are, therefore, no critical values of the rake angles in regard to power consumption as there are in regard to durability and cutting power.

6. The cutting power of a high speed lathe tool is influenced by both the cross sectional area of the shank of the tool and the nose radius, but the influence of the latter factor very largely predominates in all cases. Thus, with a number of different sections of tool steel, an increaase of the nose radius of 100 per cent produced an average increase in the cutting power of 45 per cent; whereas an increase of the cross section of the shank of the tool of 500 per cent with a constant nose radius produced an average increase in the cutting power of only 8.5 per cent.

7. The effect of raising a roughing tool so that its cutting edge is slightly above the horizontal plane passing through the lathe centers is, generally, to increase the cutting power of the tool slightly and to reduce its net power consumption slightly, when compared with its normal position, that is, with its cutting edge at the same height as the lathe center axis.

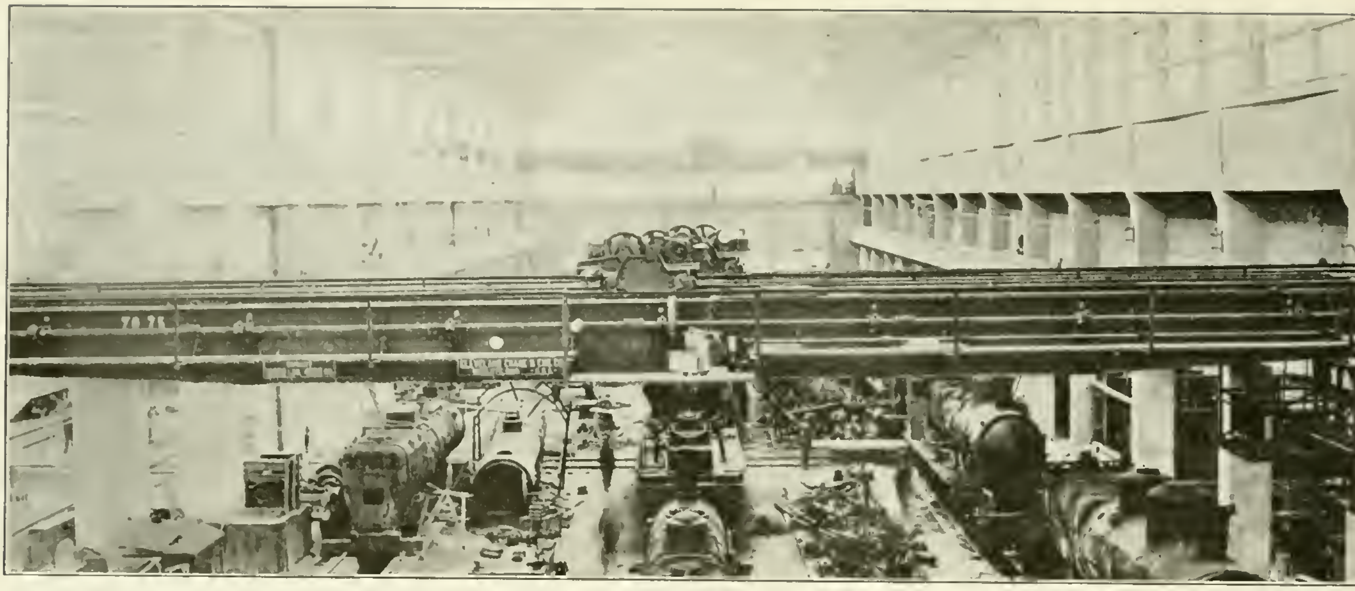
8. Forging the nose of a lathe cutting tool does not materially affect its cutting power and durability, there being practically nothing to choose between a completely ground tool and a forged and ground tool, otherwise identical.

9. The general direction and the active length of the cutting edge of a high speed tool have a slight influence upon the net power consumption of the tool, the influence being such that, with any given depth of cut, if the active length of the cutting edge is increased by an alteration of the general direction of the edge, the net power consumed is increased under conditions of working otherwise identical.

10. There is no marked difference in the net amounts of energy required per cubic inch of material removed from mild steel and hard steel bars at high and low cutting speeds.

11. The increase in the cutting power of a high speed roughing tool resulting from the use of a given stream of water as a cooling agent is greater with small cuts than with heavier ones, indicating that, with heavier cuts, heavier flows of coolant should be used. The velocity of flow of a stream of coolant does not very materially affect the improvement in the cutting power of a tool due to the use of the coolant, provided that the velocity is not such as to cause excessive splashing of the coolant.

12. The cutting efficiency of a high speed roughing tool depends very largely upon the condition of the cutting edge of the tool; and although a tool with its cutting edge blunted in the cutting process may continue to cut, it cannot be used in that condition for the purpose of starting a new cut.



Erecting Shop, Nevers, France

Mechanical Trades Schools of the A. E. F.

Short Intensive Training in the Mechanical Trades Organized in France After Signing of the Armistice

BY MAJOR C. E. LESTER

THE experience of our army in the late war in Europe taught that in modern wars the need for men well trained in industrial service is as great as the need of men trained in combat service. In putting into the field an army of a million men the service of supply is the all-important factor in the army's success, and in this service there is need of men well trained in almost every mechanical trade to keep the service functioning properly. These facts were forcibly demonstrated in more than one instance and were the prime reasons for establishing schools of various kinds in the army both in France and in this country.

The steady and enormous demand for skilled men of all crafts and professions was never entirely met prior to the armistice and gave emphasis to the fact that our peace-time army, to be self-sustaining to any degree, should be given training in production as well as destruction and that serious consideration should be given to the establishment of schools in the service where not only engineer and air service troops but all combat troops, as part of their curriculum, would be given training in the various mechanical trades.

The mechanical trades schools of the intermediate section of the service of supply constituted a unique departure from all educational projects and have occupied an altogether distinct place in the training section of the army. They form such an unusual part of the vast educational program of the A. E. F., and are so unlike anything hitherto attempted in American education, that they may reasonably be expected to have an important bearing on the possible vocational training for the peace-time army.

In the combat divisions and wherever troops could be spared after the armistice, educational courses from local studies at the Y. M. C. A.'s and post schools to scholarships in French universities were provided. In surveying the possibilities of extending the plan, the educational commission developed the fact that in the intermediate section of the service of supply there were vast manufacturing and repair plants that might in some way be utilized for the education of several thousand men in the mechanical trades who, soon to be returned to civilian pursuits, could be assisted in more thoroughly fitting themselves for a peace-time occupation and who wished increased rather than lessened earning capacity as a result of their tour in the service.

Origin of Mechanical Trade Schools Plan

The following extract from the report made by Carlton Gibson of the educational commission and later director of mechanical trade schools of the intermediate section, will perhaps give the best exposition of the plan for utilizing the Nevers locomotive and car shops as a means of affording special mechanical mechanical training to 500 men from the combat divisions: "Credit is due to the general superintendent of the 19th Grand Division Transportation Corps for the scheme of utilizing the large railroad shops at Nevers, perhaps the most attractive and best equipped shops in all Europe, for training men in all trades related to railroad transportation, a very important branch of the service. The installation in these shops of all the best types of modern machinery gave to him the vision of tying the production work of the shop with the training of several hundred men selected from the armies, in machine shop practice, foundry work, oxy-acetylene welding, blacksmithing, pattern making and other mechanical trades.

As a result of this report the following schools were decided on and established within a period of three weeks:

Nevers—Railroad Shop.
Verneuil and Romarantin—Motor Reconstruction Park.
Gievres—Signal Corps Shops.
Mehun—Ordnance Shops.
Decise—Driver Mechanics School.
Soucy—Remount School and training in the various occupations of the plants.

The need for additional highly skilled men in Nevers shop had been a problem since its inception and my desires to understudy our good mechanics with earnest boys and men who desired to further their mechanical knowledge could not be wholly gratified due to scarcity of men particularly of de-

pendable men. I saw in the desire to give men of combat troops mechanical training an opportunity to augment my forces and increase production provided that we were not hampered by the interference of dictatorial officers who were unfamiliar with shop work, or annoyed by the commanding officers of men detached to our schools.

Unusual Conditions to Contend With

It was felt that could we be allowed to operate as before and handle the schools as we desired the students could be put on a productive basis, giving them the benefit of our best efforts in expert supervision and instruction and working with our most skilled men and in a few weeks' time increase production sufficiently to compensate, or nearly so, for the additional man hours expended. It was never felt that the signing of the armistice lessened our responsibilities and the maximum output obtainable was the figure for which we were striving. How well we succeeded is another story, however, I may say, that our output increased steadily in proportion to the hours expended from the armistice till cessation of operations in May, 1919. My one thought was to so co-ordinate the school and shop that the students would receive an intensive, intelligent and instructive course of training and we would get value received in a fair day's work each day.

It may not be inappropriate to say that while the schools were authorized by General Headquarters and sponsored by the educational commission and literature issued showing the advantages of the schools and inviting soldiers of the regular establishment to take up courses and ordering to the schools such as desired to go, the burden of developing the complete courses of study and work, the organizing of provisional companies, the problems of housing, feeding, clothing, and general welfare, the problems of assimilation, the selection of instructor personnel (technical and practical) fell to the superintendent of shops.

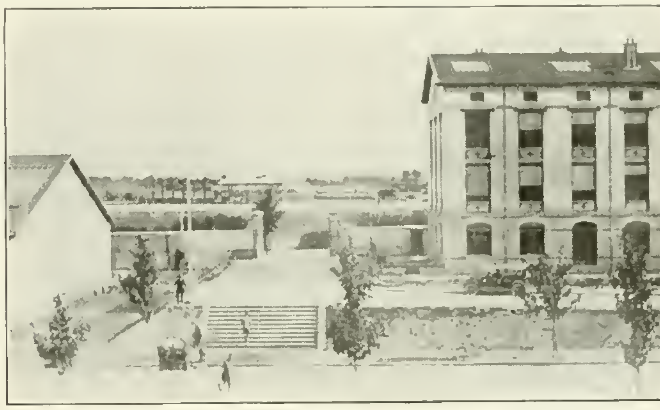
No outside assistance other than colored cooks and the administrative officers for the provisional companies was received and all duties other than these were detailed to officers of our organization in addition to their other duties. Provisional companies No. 1 and No. 2 were organized and selections from the student personnel were made to carry on the routine military duties, such as first sergeant, company clerk, platoon leaders, squad leaders, and fatigue. This work was required to be done in addition to the duties in the shop. The companies did no guard duty and no fatigue other than company but were required to stand reveille and participate in the daily short period military drill and regimental parade at retreat. This practice was inaugurated in February, 1919, for all shop men by reducing the shop hours to 8 and using one hour for drill and ceremony. This broke the monotony of the daily shop grind and assisted in keeping the men physically fit and mentally alert and gave to them the snap and set up common to veteran combat troops but seldom found in other branches of the service.

How the Work Was Organized

Immediately on obtaining information that the schools were to be established, time was taken by the forelock and a vocational officer was appointed to whose ability is due a great share of the credit for the successful operation of the schools. This officer was ably assisted by specially selected men that formed the body of the schools' instruction force. Text books were not available but we had the engineer corps field technical library as a basis to work on and developed courses of study for the several occupations before the arrival of the students. As developed, the courses were not elaborate, but included the fundamental facts and theories consistent with the trade concerned.

About the time that the schools were started it was learned that the 3 months' training period, as first planned, would of necessity be shortened by the plans to discontinue all operations not later than July 1, 1919. The scheme for utilizing one day for class room work was changed to give each student but ½ day weekly and the only subjects to be taught were shop arithmetic and applied practical mechanics. The former was a practical course in elementary mathematics with numerous applications to shop problems; the latter was intended to acquaint the student with the fundamental facts and theories of the science of mechanics which underlie all shop operations.

A course in elementary mechanical drawing was given to such students as were desirous of becoming draftsmen or those who desired to acquire a working knowledge of mechanical drawing. In addition to the practical shop work a series of lectures was arranged; these lectures to be given by various shop officers on subjects of interest to the students in various courses. This schedule was somewhat interfered with by ordering to the U. S. many of the officers concerned.



Administration Building and Entrance to Shops

In view of the shortening of the schedule as originally planned it was felt that class room work and theory would have to be sacrificed for practical work to enable the student to have sufficient knowledge of shop practices to fit him for a position after his return to the U. S. A. and his discharge from the service.

The men enrolled in the school were from all branches of service in the A. E. F. the majority being from combat divisions. The following fighting divisions were represented: 1st, 2nd, 3d, 4th, 5th, 6th, 7th, 8th, 79th, 81st, 88th and 3d army headquarters.

Selection of the Student Personnel

As the men reported they were interviewed by the vocational training officer who obtained in addition to such information relative to the man as could be judged by a personal interview, the man's age, schooling, civil and army occupation and his preference in regard to proposed training. This information was recorded on a form and used in assigning students to their duties. In establishing of the schools it was felt that those who would desire to become students would be men somewhat above the ordinary caliber and that they could be put upon an honor basis and the schools run as a college. Prior to the opening of the schools all arrivals were addressed by the commanding officer on the subject of the proposed method of running the school and the duties of the officers in charge, the co-operation expected from the workmen and the duties of the student body. Prior to this all members of the old organization had been called upon to exercise every effort and sacrifice their own desires in order to assist those who apparently needed and wanted help.

It developed, however, that there were many reasons other than study and development that brought some of the students (so called) to the schools. Some thought that by getting into

the S. O. S. that their chances of returning home quickly were enhanced, some did not want to go into Germany with their outfit and others who expected they could get out of a few week's work. The honor system did not work out with such men and they were put on a strictly military basis. In justice to the student body as a whole they were men of good character and came with the fixed purpose of improving themselves.

The splendid equipment of the shops offered unusual opportunities for practical work in the metal trades and each department was headed by men of experience, well qualified as instructors. Due to many outfits being ordered home shortly prior to the opening of the schools April 1, 1919, many men were deprived of the opportunity of attending and but 267 actually reported.

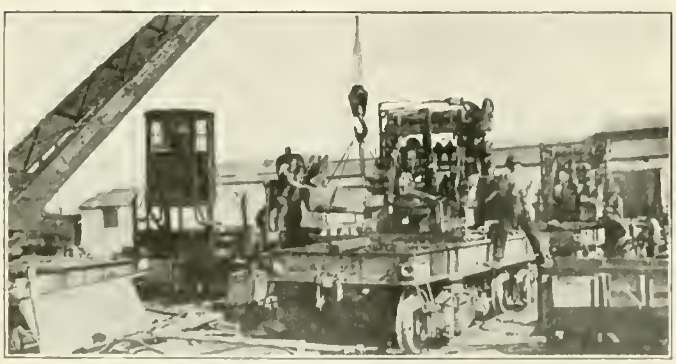
The students were assigned as follows:

Machine shop practice	82
Erecting Shop (Loco.)	48
Car repairing, wood working, pattern making	39
Sheet metal and pipe fitting	26
Electrical work	23
Foundry practice (Brass and iron)	19
Tool making and die sinking	10
Blacksmithing	13
Boiler Making	12
Autogenous and electric welding	5

Of the 82 men assigned to machine shop it was found that nearly 75 per cent had some previous experience such as running a drill press or working one particular kind of machine, and they desired to broaden their knowledge. Our machine shop was without question the most modern locomotive machine shop in the world. Every machine was the very last word in its kind, each having individual motor drive and of the latest model. The work in this department and tool room along the same lines was especially attractive to the students, more so than in any other department. Every effort was made to give the student the widest experience possible, which was considerable in a shop of this character.

Valuable Results Accomplished by School

The erecting shop offered many opportunities to the ambitious student to gather knowledge of the erection of locomotives of many designs. Locomotives built by the American and Baldwin locomotive works were assembled at Nevers as well as many types of Belgian, all types of French passenger locomotives, trench locomotives, "Economique" locomotives,



Erecting Locomotive Cranes

metre gage and German freight engines. Here one could by observation learn many things that it would be difficult to learn elsewhere. The car shop offered opportunities to men who had no previous training to pick up a trade (today rather lucrative) in a short time. This vocation is quickly and easily mastered.

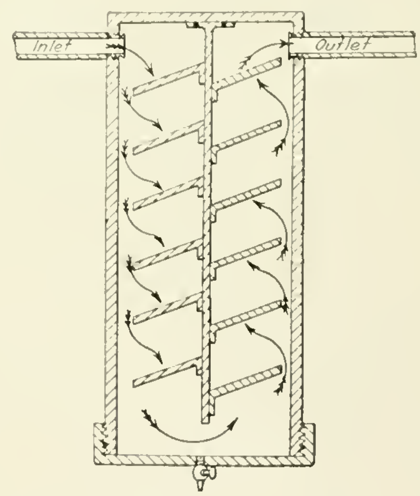
Practically all the foundry practice students were men who had some previous experience and grasped this opportunity to put themselves in readiness to accept a journeyman's job on discharge from the service. The same may be said of a large share of students in the sheet metal department.

The smith shop students were nearly all men who had been horse shoers or country blacksmiths and they all made enthusiastic students in the heavier railroad work with the steam hammers to assist. After the course was under way a card index system was developed to keep records of work done and the students' individual rating. The different department foremen and instructors were required to submit a weekly progress and rating sheet from which, with class room work included, the student's weekly rating was determined. Due to cessation of activities in the shops the schools were drawn to a close May 31, 1919, each student being furnished a certificate of studentship and forwarded to his organization or sent to an embarkation camp for return to this country.

The only regrettable thing in connection with our efforts was that the schools could not have a longer period of existence. Without doubt the men who took advantage of their opportunities of the mechanical trade schools of Nevers gained some valuable knowledge and experience to assist them in civil life that might have been doubly valuable with another few weeks' training.

SEPARATOR FOR COMPRESSED AIR LINE

In connection with the care and use of pneumatic tools the use of a separator to extract the oil and water from long pipe lines conveying compressed air is highly desirable. Some of the undesirable effects of oil and water accumulating in such lines were pointed out by H. S. Covey, secretary of the Cleveland Pneumatic Tool Company, in an address before the Railway Club of Pittsburgh, an abstract of which was printed



Sectional View of Oil Separator

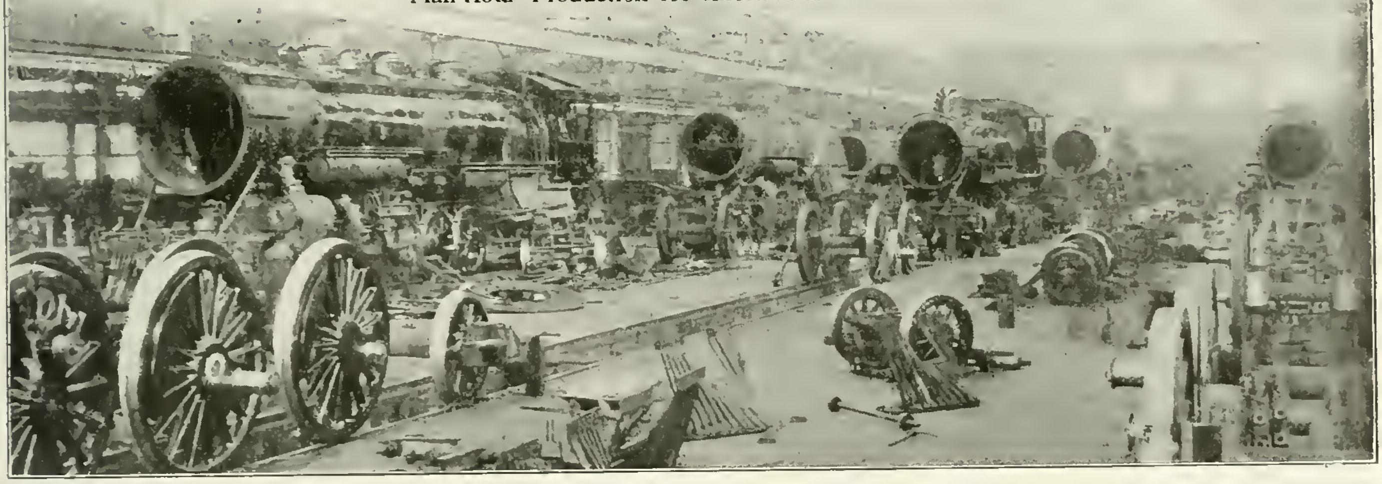
in the *Railway Mechanical Engineer* of May, 1920, page 292.

The accompanying sketch shows a sectional view of the oil and water separator referred to by Mr. Covey in his address, as follows:

The separator consists of a 3-ft. section of 5-in. iron pipe, capped at top and bottom, and is attached to the branch air pipe lines which feed the drop pipes and hose lines. The air leaves the separator at the top, entering the branch outlet pipe attached to the cap at the opposite side to the inlet. The air is thus freed from oil and such water as may still remain in the system. The separator is drained of its accumulated water and oil through the drain cock provided at the bottom cap of the separator. Occasionally the lower cap of the separator should be removed and the baffle plates cleaned by means of a stream of compressed air which quickly removes the oil adhering to them.

INTERESTING SHOP EMPLOYEES IN SHOP OUTPUT

Simple Scheme of Displaying a Comparison of Man-Hour Production for Information of the Men



One of the most marked effects of the Railroad Administration operation of the railroads is the changed conditions which it has brought about in railroad shops. Piece work, which had very extensively been employed in car shops and to a considerable extent in locomotive shops, was abolished, rates of pay re-adjusted, helpers advanced to mechanics and many shops formerly working under non-union conditions, although now nominally open shops, have become practically 100 per cent unionized. In such shops the organization and operation of grievance committees has been an innovation to which both men and shop managements have had to adjust themselves. The result of all these changes has been a disturbance which has affected output, more or less seriously, in almost every railroad shop of importance in the country.

The changed conditions have required new measures on the part of the managements to bring production back to reasonably satisfactory standards. At one shop where, during the latter part of last year, a marked falling off in the man-hour output was being experienced an ingenious means of presenting a comparison of output by months of the current and preceding years in a form which could readily be comprehended by the men in the shop, was developed and employed with gratifying results.

The plan had its inception in a conference between the local shop committee, the shop officers and the superintendent

OUTPUT METER.

PERCENTAGE BASIS.

R 1	100	C 3	70	H	40
R 2	90	H 4	60	L	30
R 3	80	H 5	50	S	20

	APRIL 1919 WEEK ENDING					APRIL 1920 WEEK ENDING				APRIL 1920. % GAIN. WEEK ENDING				APRIL 1920. % LOSS. WEEK ENDING				APRIL 1919 MEN EMPLOYED	APRIL 1920 MEN EMPLOYED	APRIL 1919 HOURS WORKED	APRIL 1920 HOURS WORKED
	5.	12	19	26		3.	10.	17	24.	3.	10.	17.	24	3	10.	17	24.				
R	3	2	3		R	3	2	3			12%			9%		6%		602	555	40	54
C	1				C													REMARKS.			
H	2	2	1		H	3	6	5													
L	2	4	4		L	5	2	1													
S					S																
TOTAL ENGs					TOTAL ENGs					TOTAL %				TOTAL %							

1919.	ENGS. OUT	1920.	ENGS. OUT	1919. HOURS WORKED	1920. HOURS WORKED	1919. MEN EMPLOYED	1920 MEN EMPLOYED	% GAIN	% LOSS
JAN.	41	JAN.	38	208	234	592	600		18%
FEB.	26	FEB.	30	175	216	608	567		.03%
MAR.	30	MAR.	40	173	243	618	578	5%	

Form of Board on Which Comparative Output Figures May Be Bulletined for the Inspection of the Men in the Shops

of motive power, at which the facts of the situation were laid before the committee. When confronted with a statement that the shop had actually suffered a decline in output the members of the committee were loath to believe that the situation was as represented. An inspection of the records of men employed, hours worked and locomotives turned out, however, convinced the committee, one of whom expressed the opinion that, if they knew them, no one would regret these facts more than the men in the shops and that if a means were available for laying before the men the month to month facts as to output they would remedy the situation themselves.

As the result of this conference the scheme here described for calculating and recording the month to month output on a comparative basis was developed.

In order that a reasonably satisfactory comparison of output might be made some method of weighting the various classes of repairs was necessary. This was worked out on a so-called point basis, each class of repairs being assigned a number of points such that the numbers assigned to the different classes of repairs would bear a relationship to each other approximating the relationship between the actual man-hours of labor required on the average locomotive going through the shop for the different classes. The following number of points have been assigned to the various classes of repairs:

Class 1 rebuild (new)	100
Class 2 rebuild	90
Class 3 rebuild	80
Class 3 general	70
Class 4 heavy	60
Class 5 heavy	50
Heavy	40
Light	30
Specific	20

This classification is posted at the top of the output meter board which is placed in the shop where it is accessible for the inspection of the men.

In order to eliminate the effect of possible variations in conditions from month to month, the comparison is made between each month of the current year and the same month of the preceding year. The comparison is expressed as a per cent loss or gain, as the case may be. A simple formula has been worked out for the calculation of this per cent and a blueprint copy of the formula is posted near the output meter board in order that the basis of comparison may be generally understood. The first step in the calculations is the determination of the aggregate number of points equivalent to the output for the month. With a knowledge of the number of locomotives in for each class of repairs which was turned out during the month, this is readily determined by referring to the percentage or point basis just described. The next step is the determination of the total man-hours worked, which is the number of shop hours for the month multiplied by the number of men employed. The basis of comparison is then arrived at by dividing the total number of man-hours worked by the number of points, giving the number of man-hours which were required to produce one point. The proportion of increase or decrease of this figure for the current month is the measure respectively of the loss or gain of output per man-hour. This is entered in the proper percentage column.

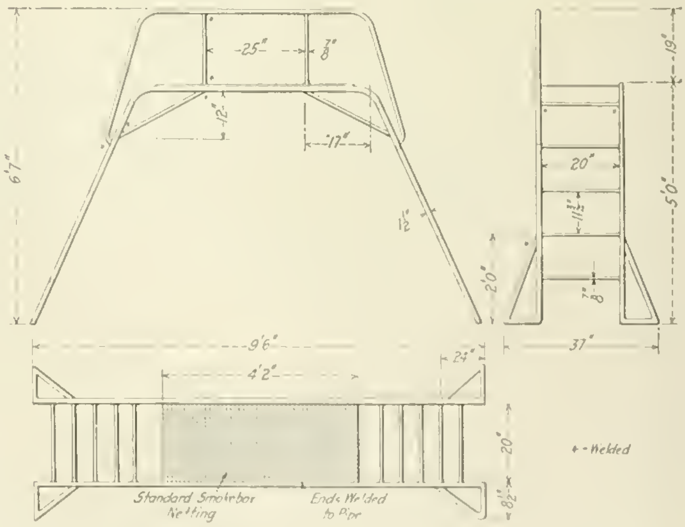
Reference to the drawing will show the method of posting the information. It will be seen that the middle portion of the board is divided into three sections and each section in turn is divided into two parts, one devoted to the current month and the other to the same month of the preceding year. Each part is provided with a column for each week of the month, in which the number of locomotives receiving each main class of repairs which was turned out of the shop during the week is entered in the first section, and the percentage of gain or loss entered in the proper part of the second section. In the third section is shown the number of men employed and the number of working hours per week for the current month and the same month of the preceding year. As shown on the drawing the column captions of this section of the board are lettered on a removable strip of sheet metal which is pulled out of the slide at the end of each month and replaced with one lettered for the next month. In entering the figures in this section, white chalk is used for those for the current month and red chalk for those for the preceding year. The permanent figures in the lower section of the board are painted in the same colors.

The lower section of the board is devoted to a similar record by months, a complete record of the calendar year being entered here month by month.

The scheme is simple to operate and is readily understood by the men. Its value is indicated by the results shown for the first three months of the current year. That the men have taken an interest in the success of the shop is clearly indicated by the marked improvement in output which has been obtained since January and the significant fact in connection with these figures is that the improvement has been effected almost entirely by the men themselves. With the facts as to conditions clearly before them, no other measures have been necessary to bring the output back to and even to exceed that of the same period of the preceding year.

SAFETY PLATFORM FOR THE ERECTING SHOP

The cab of a locomotive, after the engine has been cut off from the tender and placed in the erecting shop, is rather a dangerous place to work and casualties are frequently caused by men stepping off the apron and falling into the pit. In order to remove this element of danger the platform shown in the drawing has been developed and used successfully for some time in the Battle Creek, Mich., shops of the



Platform for Use Back of Locomotive Cabs in the Erecting Shop

Grand Trunk, Western Lines. The frame is built up of pipe and cross pieces of ⅞-in. material, which are welded to the pipe. At the base the frame is 9 ft. 6 in. long and spans the working pit, the height of the platform being 5 ft. above the level of the shop floor. The platform is covered with standard smokebox netting and a pipe rail 19 in. high is placed across one side.

The platform is placed across the pit just back of the locomotive, the front side extending under the back edge of the apron. It thus increases the working space in the cab and provides a safety rail which is an effective protection to the men. The cross pieces between the two frames also facilitate climbing in and out of the cab.

Nickel Plate Power Plant at Conneaut

Results of a Successful Superheater Installation in the Stationary Boilers at Conneaut, Ohio

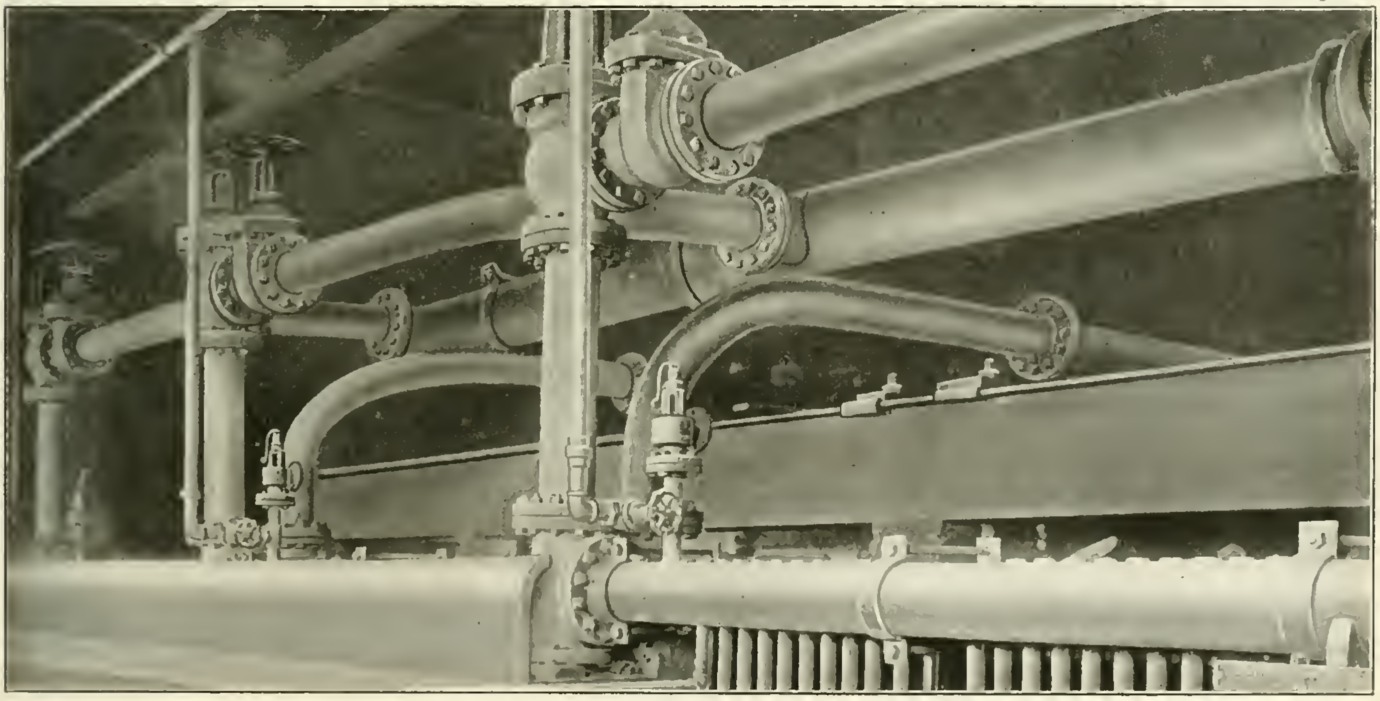
BY J. S. MORRIS
Assistant Engineer, N. Y. C. & St. L.

During the past few years, the traffic handled by the Nickel Plate has gradually increased, with the result that the shops and engine houses have had to increase their output considerably. This, of course, caused the load on the boiler plants to increase to such an extent that during the winter months the boilers had to work under a heavy overload. The conditions at Conneaut reached a point where it was necessary either to purchase additional boilers or to increase the output of the boilers then in use. At this time it was suggested that superheaters would solve the difficulty.

Assuming that the use of superheated steam would increase the capacity of the power plant 15 per cent, the cost of the superheater installation would be approximately two-thirds the cost of installing another horizontal return tubular boiler of a size sufficient to give the same increase in capacity. Not only would the first cost of the superheaters be less but it was thought that they would show an annual fuel saving of at least 10 per cent with the same load, which would not only pay the charges against the investment, but would leave a substantial margin of profit besides. If an additional boiler was installed, the fuel consumption would probably increase, especially at times when the plant was not working under full load.

The engine room, which is located adjacent to the boiler house, contains the following machinery: one 100 H.P. high speed Buckeye engine with piston valves, direct connected to a 75 K.W. direct current General Electric Co. generator which supplies electric power for all of the motor-driven machinery and electric lights for the entire shop; also one 1,050 cubic foot Ingersoll-Rand air compressor with slide valves on the steam cylinders and a 150 H.P. simple Corliss engine which drives all the belt-driven tools in the machine-shop.

The boilers also supply steam for a 75 H.P. Erie City slide valve engine located in the wood mill, about 400 ft. from the boiler house. In the blacksmith shop they have one 1,200-pound steam hammer and one 2,000-pound hammer. A twenty-eight stall engine house located about 600 ft. from the power plant uses steam to blow up engines, and also to operate the engine house. Steam is conveyed to the engine house by means of a four-inch underground steam line. This line is carefully insulated against heat losses and offers several important advantages over the more common type of overhead steam line.



Superheater Header Installed at Conneaut

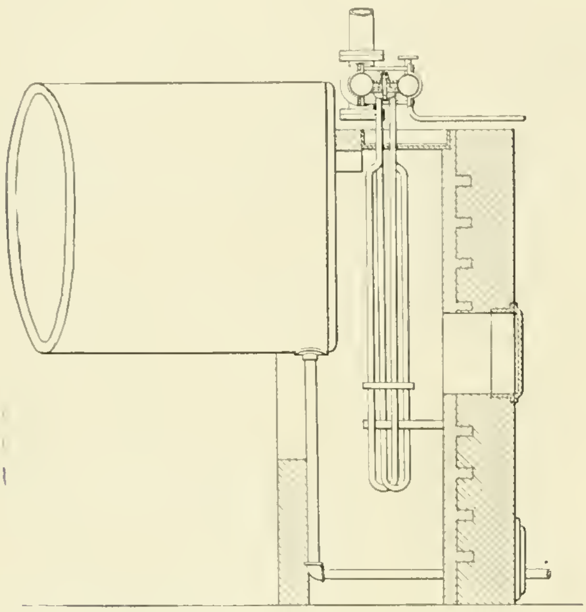
Description of Power Plant

The boiler house now in use was built in 1913 and contains three 180 H.P. horizontal return tubular boilers, built by the Bass Foundry & Machine Co., and two 70 H.P. Erie City boilers of the same type. All of the boilers are hand fired and use run-of-mine bituminous coal with an average heat value of 12,500 B.t.u. per pound. Each of the three 180 H.P. boilers has 35-inch steel smoke stacks 100 ft. high and the two small boilers have 28-inch stacks the same height.

Description of Superheaters

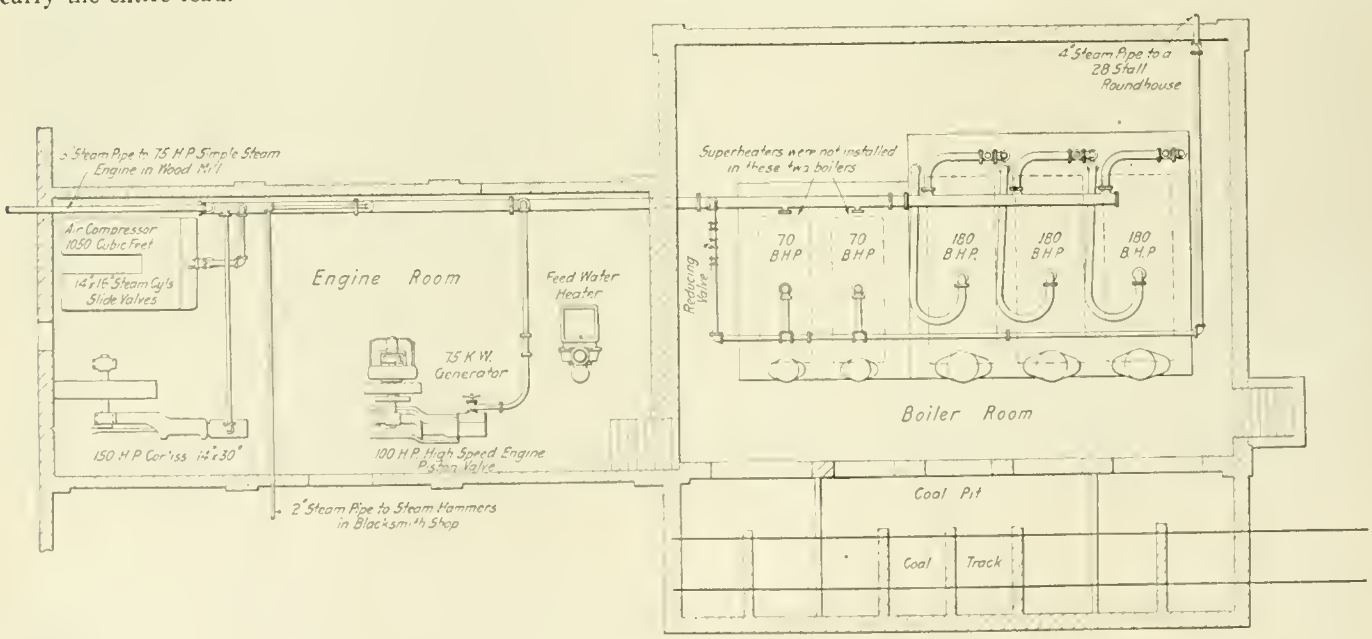
During the month of September, 1919, superheaters were installed in each of the three 180 H.P. return tubular boilers. The superheaters were designed and installed by the Locomotive Superheater Co. The superheater header is hung horizontally just back of the boiler, with the ends resting on the side walls. The header is constructed of steel and is in two sections; one section for saturated steam and the other for superheated steam. The units, which are made of 1½-inch cold drawn seamless steel tubing, hang vertically from the header in the space between the rear of the boiler and the back wall.

The ball joint on each unit is forged integral with the tube and is clamped to the headers by means of a specially designed forged steel clamp, similar to the arrangement used on locomotive superheaters. The units are arranged in one loop per unit and each boiler has sixteen units with a total of 104 sq. ft. of heating surface.



Superheater Header and Units in Place

Superheaters were not installed in the two 70 H.P. boilers; and in order to separate the superheated and saturated steam, these two boilers were disconnected from the main header and connected directly to the engine house line. A by-pass line was installed between the main header and the engine house line so that the two small boilers need only be used during periods of the year when the three 180 H.P. will not carry the entire load.



Outline of the Power Plant at Conneaut

Results of Tests

From three to six weeks before the superheaters were installed four complete power plant tests were conducted. Two of these were of eight hours' duration with the power plant carrying the regular shop load from 8 a. m. to 4 p. m. and the other two tests were made at night with the different engines loaded by artificial means. This load was maintained constant for four hours.

About three weeks after the superheaters were installed, three similar tests were conducted and as far as possible conditions of the original tests were duplicated.

All the coal consumed by each boiler was accurately measured by weighing on platform scales. The feed water was measured by means of a recording water meter which was accurately calibrated before and after each set of tests, and was located between the feed pump and boilers. The average indicated horsepower of the Corliss and wood mill engines was secured by indicator cards taken every five minutes. Switchboard readings were taken at the same intervals. A proximate analysis and heat value of the coal was secured from samples taken during each test.

The two tests shown in Table I were made from 8 a. m. to 4 p. m. with the regular machine shop load on the three 180 H.P. boilers. During these two tests the engine house load was carried on another set of boilers. The two tests shown in Table II were made at night with each engine running under a constant load for four hours, with blacksmith shop and engine house lines cut off.

Table I—Results of Eight-Hour Tests with Boilers Carrying Shop Load Only

	Saturated steam	Superheated steam	Per cent increase	Per cent decrease
Total coal consumed, pounds	17,061	13,469	....	21.1
Steam consumption, pounds	128,100	98,500	....	23.1
Average steam pressure of boilers	115.0	113.6	....	1.2
Average load on Corliss engine, I. H. P.	60.1	59.1	....	1.7
Average load on wood mill engine, I. H. P.	47.9	56.1	17.1	....
Average load on electric generator, kw.	36.8	40.5	9.1	....
Total air compressor revolutions	51,580	47,825	....	7.3
Steam hammer No. 1, minutes in use	175	249	43.5	....
Steam hammer No. 2, minutes in use	221	253	14.5	....
Temperature feed water, degrees F.	209	206	....	1.4
Equivalent evaporation at 212 deg. per pound dry coal	7.96	8.47	6.4	....
Efficiency boiler, furnace and grate	58.8	62.4	6.1	....
Heat value 1 lb. dry coal	13,390	13,190	....	1.5
Average boiler horse power developed	487	403	....	17.2
Per cent of rated capacity	90.1	74.6	....	....
Degrees superheat at main header	....	152	....	....
Degrees superheat at air compressor	....	127	....	....
Degrees superheat at Corliss engine	....	103	....	....
Degrees superheat at wood mill engine	....	14	....	....

Practical Results Obtained

The following table shows the number of tons of coal consumed by this plant during the past three winters, with satu-

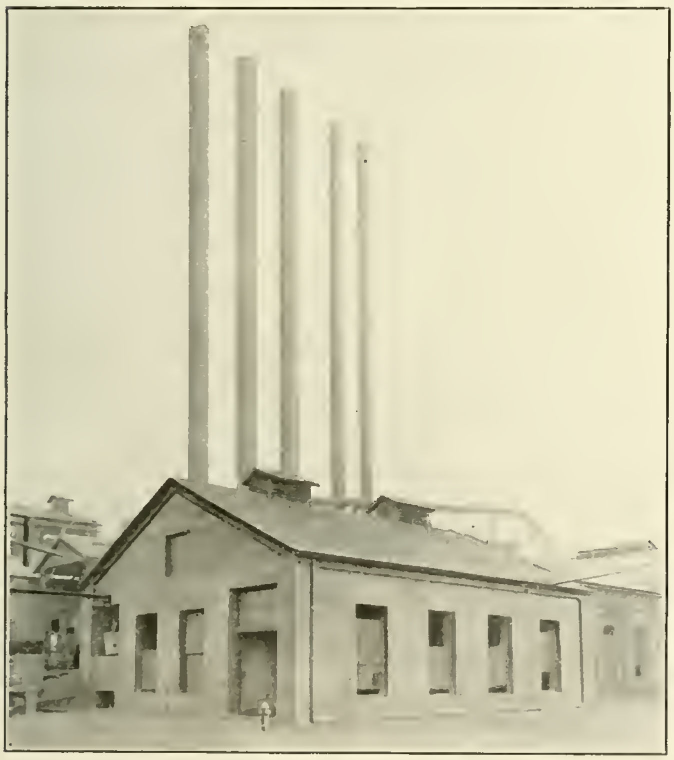
rated steam used during 1917-18 and 1918-19 and superheated steam during 1919-20:

Tons of Coal Consumed Per Month

	1917-18	1918-19	1919-20
October	838	1,087	797
November	952	885	877
December	1,314	1,174	1,080
January	1,371	1,174	1,340
February	1,125	1,062	1,116
March	1,311	1,105	1,066
Total	6,911	6,487	6,276

It is apparent that a very material saving in fuel has been effected by the superheaters. A comparison of the past winter with the winter of 1918 and 1919 is not entirely fair as the past winter was very severe and long and the fuel obtainable was of poor and very irregular quality, while the winter of 1918-19 was mild throughout and the fuel obtainable was the best. Even under these conditions the superheaters show a considerable reduction in the amount of coal consumed.

A comparison with the winter of 1917 and 1918 is more nearly fair, as the weather and fuel conditions were about



The Boiler House at Conneaut

the same as during the past winter, and in this case the superheaters show a very marked reduction in the amount of coal consumed.

Fuel economy is not the only benefit that has been obtained from the installation of these superheaters. A very important result has been the improved operation and output of the different steam engines, steam hammers, air compressors and blower lines. No figures are available showing the actual savings due to this cause, but experience has demonstrated that the improvement has been considerable. Especially was this noticeable in the wood mill engine, which is located about 400 feet from the boilers. Before the use of superheated steam, this engine was badly handicapped during the winter months, due to the large amount of condensation in the three-inch overhead steam line, with the result that it was unable to keep the wood mill machinery operating up to the speed at all times. Since the superheaters were installed this trouble has been entirely eliminated and the engine has sufficient power to easily handle the wood mill load.

The same condition existed but to a less extent in connection with the engines and in the main power plant, as there has been a decrease in the condensation and friction losses in the four-inch underground steam line. From several tests it was found that the pressure available at the engine house was from five to ten pounds higher with superheated steam than with saturated.

At the time the superheaters were installed there was some question whether the slide valves on the air compressor would operate successfully with superheated steam. About two months after the installation the valve chest covers were re-

Table II—Results of Constant Load Test Made at Night

	Saturated steam	Superheated steam	Per cent increase	Per cent decrease
Total coal consumed, pounds	9,316	6,827	....	26.7
Steam consumption, pounds	57,500	46,000	....	20.0
Average steam pressure of boilers	118	115	....	2.5
Average load on Corliss engine, I. H. P.	43.0	43.6	1.4	....
Average load on wood shop engine, D. H. P.	43.2	42.8	....	0.9
Average load on electric generator, kw.	56.7	56.8	0.2	....
Total air compressor revolutions	26,590	26,630	0.1	....
Temperature feed water, degrees F.	212	207	....	2.4
Equivalent evaporation at 212 deg. per pound dry coal	6.63	7.82	17.9	....
Efficiency boiler, furnace and grate	47.6	57.7	21.2	....
Heat value 1 lb. dry coal	13,510	13,190	....	2.4
Average boiler horse power developed	386	336	....	12.9
Per cent of rated capacity	107.0	93.3	....	....
Degrees superheat at main header	....	163	....	....
Degrees superheat at air compressor	....	143	....	....
Degrees superheat at Corliss engine	....	119	....	....
Degrees superheat at wood mill engine	....	9	....	....

moved and it was found that the valve seats were in good condition and have caused no trouble since. Except for the installation of additional valves, together with the changes in connections incidental to the superheaters, the power house steam lines have not required any rebuilding and are giving satisfactory service. Shortly after the installation, two or three of the old flange gaskets in the main header blew out and had to be replaced. On one or two occasions it has been necessary to tighten up the units, which proved a simple matter, as all these bolts are accessible from outside the boiler setting.

Burning Eastern Coals on Conveyor Feed Type Stoker.—Difficulty has been experienced in burning eastern bituminous coals on chain grate stokers, due to the fact that they cake under the arch, preventing the entrance of air through the fuel bed and checking combustion. In a paper presented before the American Society of Mechanical Engineers, Lloyd R. Stowe described a stoker developed by the Laclede-Christie Clay Products Company, which it is claimed may be used satisfactorily with eastern bituminous fuels. The stoker is of the conveyor feed type and operates with mechanical draft. High ignition temperatures are employed. The air supply is graduated from the feeding end to the discharge end and the fire is thickened at the point of ash discharge. These features are said to result in the prevention of caking, the assurance of a CO_2 content of from 10 to 12 per cent and intimate mixture of air with the combustible gas. Rates of burning up to 60 lb. per square foot of grate area per hour are obtained as compared with 25 to 35 lb. on chain grates. The percentage of combustible in the ash is reduced 50 per cent.

Government operation has left the country with an insufficient number of cars and locomotives, and with an unusual proportion of the existing equipment out of order. There is to be a shortage of cars for a long time to come. It is well to know where responsibility for it chiefly lies. But the really important thing just now is to look ahead and make arrangements for the most efficient use of such cars as the country has in working order.—*Boston Transcript.*

Looking Down the Erecting Bay in Silvis Shop

Reducing the Cost of Locomotive Repairs*

Use Modern Tools and Scheduling System; Keep Men at Their Jobs; Avoid Unnecessary Finish

BY S. W. MULLINIX

Superintendent Shops, C. R. I. & P., Silvis, Ill.

REDUCING the cost of repairing and maintaining locomotives has been open for discussion ever since railroads have been in existence and is one of the most important questions which confronts the mechanical department today; one which can only be solved by careful study and efficient handling, plus good, hard, honest labor.

In order to be brief, and to cover the subject as thoroughly as possible, I will divide the cost between labor and material, treating each one separately.

Labor

Never before has labor in all its branches required the efficient handling that it does today, and in view of the enormous increase in the cost of labor, we must find methods of increasing the production of every employee.

Make use of all existing labor saving devices, such as electric and oxy-acetylene welders, high speed tools, drills and cutters, air tools, electric trucks, cranes and hoists. Create wherever possible new labor saving devices, or better methods of doing the work. Purchase where possible modern machines to replace obsolete machines found in a great many railroad shops today. While a great many modern machines and tools have been installed, we have not kept pace with other manufacturing industries in the purchase of tools and machinery to handle repairs to the present locomotives. Establish and maintain rigid standards on as many parts as possible that they may be manufactured in quantities on machines especially adapted for the purpose. This alone will save many dollars in labor in small shops and roundhouses that are forced to furnish parts they have not the facilities to make, which might just as well have been manufactured in larger shops, or better still, in a separate manufacturing plant.

Rearranging and Regrouping Machines

The rearranging and regrouping of machines to eliminate the handling of material from one part of the shop to another often produces great savings. I recall one case where machines were rearranged for repairing driving boxes. From the time the driving box was placed on the floor to be overhauled complete with crown brass turned, shaped and pressed into box, gibs and lateral face applied, drilled, plugged and planed, the cellar fitted and the box bored ready to apply on the journal, it traveled just seventy-two feet, and part of this distance was from one hoist to another.

In another case on the repairing of flues, from the time the flue was started on the first machine, after it had been rattled until it was completed, safe end applied, cut to length, tested and annealed, it traveled just sixty feet, with no back hauls whatever.

Dividing Shops Into Separate Departments

When large enough, divide shops into small departments, such as rod and link, wheel, air, etc., giving each, machine and equipment enough to perform its own work without depending on some other department. Have some one responsible for the performance of each department.

Cleaning and Stripping Engines

Engines and tanks should be thoroughly cleaned, all coal and cinders removed, and the boiler washed out before the engine is placed in the shop. Cleaning vats should be located as near as possible to the place where engines are being stripped and parts should be cleaned before being sent to the various parts of the shop to be repaired. All parts removed should be stenciled or tagged with the engine number so they may be replaced on the engines they were removed from. Many small pieces find their way to the scrap dock because they are not properly marked.

Do no more stripping than is absolutely necessary. We should be as careful in stripping an engine as we are in assembling it, for every piece removed must be replaced. We sometimes take down parts that were renewed or put in 100 per cent condition in some roundhouse only a few days before the engine was sent to the shop. Sometimes, in

*Paper presented at the Western Railway Club, on April 19.

order to get a few more miles out of the engine, after general repairs are authorized, steam pipe joints are ground and pipes reset. Piston or valves may have been renewed. In the event of any parts of the locomotive being in 100 per cent condition, the division people should so notify the shop. Care and good judgment should be exercised in stripping locomotives that come in for general repairs. A sledge and chisel bar in the hands of some one who does not know just what to remove, and how to remove it, can destroy in a few minutes that which will take much time and money to replace.

Engines should be carefully inspected before being placed in the shop, and also while being stripped, and parts such as pedestal binders, where found loose on the frame fit, should be marked the amount necessary to close before being removed, and should be repaired before being sent back to the engine.

Testing and Annealing Parts Removed

Parts removed, such as piston rods, valve stems, motion work, brake and spring rigging, crank pins and axles, and main and side rods after being cleaned should be carefully examined for cracks and flaws. Where possible they should be painted with a thin coat of good white-wash; this also applies to frames. After this has dried for some time, if there are any cracks or small checks, the oil or grease will work through the white-wash and can plainly be seen. It is also good policy to anneal as many of these parts as possible as undetected flaws will show up while the pieces are hot.

Work Reports

An engine sent in from outside points should be accompanied by work reports, made out by the person having direct charge of the engine, as he knows the good and bad points of the engine under his charge, and is more competent to make out an intelligent report that will be of some use to the shop. The practice in many places of filling out the form furnished by the office, is to mark after each item "Repair" or "Examine," being sure to name all parts of the engine, so that if any defects are found after the engine has been repaired they can place responsibility on the shop making the repairs by referring to their work report.

Too much care cannot be taken in making out an accurate work report. All defective parts which have been giving trouble should be so reported, parts which have recently been repaired and are in good condition, such as air pump, crossheads, piston and valves, lubricators, injectors, and reversing gears, should be so reported, which will save the time and labor of removing and examining them.

Locomotives scheduled for the shop should be examined as far in advance of shopping as possible, to determine repair part requirements so that the store department will have plenty of time to meet the demand by placing orders for castings and other material not on hand. This examination should be supplemented by a more minute check while the locomotive is being stripped, at which time parts are more accessible. Care should be exercised to prevent the diverting to other uses of material intended for locomotives in the shop.

Every effort should be exercised to abolish the so-called "robbing system," a process used in reality as a substitute for material short in the store. Main shops of many railroads are called upon to furnish new and second hand material for shipment to outside points for ordinary as well as emergency use. Outside points are guilty of ordering such repair parts for emergency use in order to insure delivery when in reality there is plenty of time to manufacture and deliver. The removal of parts for such purpose from locomotives awaiting shop is expensive. Very frequently such parts as side and main rods, guides and cylinder heads that have been carefully refitted to the locomotives in the shop are removed and shipped.

Keeping Men at Their Work

Tool room and portable tools should be located in convenient places with respect to points where work is being performed to avoid unnecessary errands of mechanics and helpers.

Each employee should be given his assignment of work and to make it possible for him to perform it in a reasonable length of time, he should be given a fit place to work, proper tools to work with, supplied with working material, and, if necessary, instructed how to do it. This eliminates the need of men going from one department to another to get material and information. I recall one case which happened some time ago; the man operating the machine planing crossheads for guide fit, after getting the crosshead on the machine, would start out to find the size of the guide. Going first to the engine in the erecting shop, and not finding the guides, he would come back to the guide planer. If guides were not planed he and the man operating the machine would determine what size the guides would true up at, so he could go ahead and plane the crosshead to suit. This can be eliminated by having the foreman examine the guides while the engine is being stripped, and determine just what is needed and filling out a form made especially for the purpose, in two copies, which shows guides to be planed, the size to plane them to, or whether they are O. K. also giving the size. These forms should be sent to the guide and crosshead planer. In this way when the planer operator is ready to plane the crossheads, say for engine 2500, he takes the slip for this engine which shows right top guide planed to 7⅝ in. or the right top guide O. K. 7⅝ in, and so on for the other three guides, then planning the crosshead 1/32 in. wider for clearance. This eliminated the necessity of either operator leaving his machine. It also enables the crosshead man to repair and plane the crossheads and deliver them to the erecting shop in many cases before the guides are planed.

The same applies to laying out shoes and wedges for driving box face. In most cases the men doing this work wait until the driving boxes are planed, making several trips back and forth to see when they will be finished. Most shoes and wedges are laid out to a 1-in. gauge. A good procedure for this work is as follows: As soon as the engine is blocked and binders refitted, shoes and wedges are put up and laid out, taking the size of the box from blue prints which we will call 14 in. Shoes and wedges are laid out for a 14-in. box, allowing for a 1-in. gauge and sent to the machine shop to be planed. Work on the spring rigging can then proceed and the engine be made ready to wheel when the foreman in charge of driving boxes has them finished. He calipers each of the boxes which are planed in pairs where possible. In all cases boxes should be bored central with shoe and wedge faces.

If the box, which according to the blue print should measure 14 in., calipers only 13½ in., he makes out a slip, showing the right and left shoe and wedge to be planed to a 1¼ in. gauge, giving the slip to the men operating the shoe and wedge shapers. In cases where there is not enough stock to true up the size given they are planed 1/16 in., ⅛ in., or 3/16 in. and liners applied to the inside. This should be done before shoes and wedges are sent back to the erecting shop. If possible a small drill press and bench should be located close to the shoe and wedge shapers.

On piston valve engines the gang foreman should examine the bushings and if out of round or worn hollow, he should fill out a form to be sent to the valve bench, which shows the engine number, whether the bushings are O. K. and giving the size, or whether they are to be bored and to what size they will bore out. A good practice is to bore valve bushings only twice, ⅛ in. or ¼ in. over the original diameter. All rings and bull rings can be fitted to a bushing made for this purpose, and only in rare cases is it necessary

for men on the valve bench to go to the engine to fit rings. It also enables them to fit up their valves before the bushings have been renewed or rebored and makes it unnecessary for one department to wait on another.

The use of portable machines in the erecting shop for fitting frame and guide bolts, and for special pins and studs will save many trips from the machine to the erecting shop.

Roundhouses of any size should be equipped with enough machinery to handle their own work, especially their small work, as many hours of costly labor are consumed by mechanics and helpers going back and forth from the roundhouse to the back shop to get some small job done, which in itself interferes with the routine work in the back shop.

Routing and Scheduling

In all shops larger than the so-called one-man shop, there should be some method of routing engines and work through the shop, or a schedule system which will enable all departments to know just what work is to be finished first and when it is expected. Such a system enables the man in charge to tell just what departments are holding back the output. In nearly all shops the output is controlled by one department, and any steps that will tend to build up this weak department will increase the output. It is very essential that our forces be equalized.

No matter what the system, whether it be simple or elaborate, it will be of no use unless it is followed up and followed up religiously.

Supervisory Forces

One of the most important factors in increasing the efficiency of shops and roundhouses is the supervisory force. It is up to these men to make a careful study of their own particular class of work and department. They should be thoroughly familiar with locomotives and the tasks they have to perform and the conditions under which they have to perform them.

I believe a gang or boiler shop foreman should have some roundhouse experience, as only by actual experience do we realize what the roundhouse people have to contend with, and to know the things which give the most trouble. A machine-shop foreman should have some erecting shop experience; he should also be familiar with the so-called standard practice cards used in a great many shops to describe the manner of doing different classes of work. These foremen should be examined from time to time to make sure that they are familiar with all standard practices.

The staff meetings held once a month or oftener if possible, are very good if conducted with the spirit of making all feel that they are officers of the company and bringing them to realize the importance of doing their duties as such. We must increase our production without increasing the physical exertions on the part of the employees. I recall one instance which will give a good illustration. We used to saw cylinder packing rings by hand, which for two cuts required at least 15 minutes of hard labor. The rings are now cut in a special machine requiring only one blow with a light sledge and about two minutes' time.

The supervisory forces in large shops today are often compelled to use their judgment in doing certain pieces of work against that of the district or division mechanical people. An engine may have a cracked cylinder. The district or division people will in most cases recommend a new cylinder. The shop people after an examination may decide to weld it. In some cases we are unsuccessful, which results in our having to apply new ones, but there are many cases where the welded cylinders have given just as good service and have saved the company many dollars in labor and material. This applies to many other items besides cylinders.

The handling of men today to get the best results is a far greater task than it was years ago. What will work in one case will not apply in another. It may be necessary to drive one man, beg the next and pray to another, but the course that will bring results is the one to use, and use continuously and eternally.

Suggestions from the Men

Many good suggestions will come from the rank and file if they are solicited in the proper spirit. Where we find a man trying to better conditions we should encourage him. It is not in our power to compensate him beyond his regular wage, but it is our duty to give him credit for the good things he does. It is surprising what good can be accomplished by patting a man on the back once in a while. In order to be efficient, men must be contented. This was shown very clearly during the period when the wage question was being settled.

If men are to be contented they must have good surroundings. The first impression a man has when he starts to work in a new place in all probability is a lasting one. If he is given a dirty locker, a broken monkey wrench and other tools not fit to work with, the chances are that, although he is a good man, he will be dissatisfied and will not remain with us. Men should have clean lockers and lavatories. If given good tools and a good drawer or box with a lock to keep them in, you will find that they will take care of them.

A man should be given his task to perform and if he is contented he will perform it.

Any job that is worth doing is worth doing right, and do not put off until tomorrow the things that should be done today, especially in a roundhouse. Although these things are as old as the hills, they are far more important today in reducing the cost on our locomotives than they were when they were written.

Visiting Other Shops

A great deal is accomplished by going to other shops to make observations and study the progressive features, whether they be large or small. We often run across kinks that are good and productive of reducing costs. A few years ago I had occasion to visit a large locomotive shop and noticed the operator anchoring a cylinder bushing preparatory to boring it out by means of two ⅝-in. chains, each with a clevis on one end and an eye bolt on the other. The clevis was made fast to the bracket of the bed plate, the chain then thrown over the bushing and the eye bolt put through the bed plate, with the nut on the under side, thus taking the place of clamps, blocks and bolts. Besides, the job is done in less than half the time and is more secure. I lost no time when I returned to my home shop to tell the operator of the arrangement. He at once ordered the chains, and now you could not get him to part with them.

We send foremen occasionally to other shops and they never return without bringing something that is an improvement over what we have. My experience has been when visiting shops that the officers in charge have always been glad to impart any information asked for, and also seem to take pride in showing their practice. If we feel that our methods are better than theirs we should say so.

We often get many good kinks from the supply men, as they have the advantage of seeing how work is being done in a great many shops, especially those who had been connected with the mechanical department.

Material

Material represents approximately 40 per cent of the cost of repairing and maintaining locomotives, a large part of which is purchased either rough or finished. Owing to the high cost of labor and the absence of modern and special production machines in many railroad shops, there are many articles which can be purchased finished cheaper than they can be manufactured on our railroads. There are also many articles sent from the purchasing to the mechanical department to be tested to see how they compare with home-made

articles, as well as to compare them with similar articles from other manufacturers. These tests should be given careful consideration, as they very often decide a standard for an entire system. Sometimes what is considered a successful article or tool in one shop is complained of by another. For that reason when an article is being tested it should be gone into thoroughly and passed on by competent employees.

Have any of us ever stopped to figure in dollars and cents the amount of labor which has been wasted on materials, such as hard castings, requiring twice as long to finish as it should? How often do we find, after spending many hours of labor on some piece of material, that it is full of blow holes or cracked? It has no doubt been passed on by the test department, but no matter how thorough they are they will not find all of the defects, especially in rough material. It is up to us to examine very carefully and to use good judgment in passing on material which is to be finished. True, the people we purchase the material from will replace the rough material, but they do not pay for transporting it back and forth to the store department, and from there the handling to the shop and back, or the amount spent for labor in the shop.

The mechanical department should work very closely with the store department on unsatisfactory material, calling their attention promptly to any article that is not standing up or giving the service that should be expected, so they can get in touch with the manufacturers for correction.

During the war period the locomotive costs have also been greatly affected, due to shortage of material, making it necessary to substitute all classes of material.

The mechanical department is to blame to some extent for this condition, due to the changing of patterns and specifications. These changes, no doubt, are paying propositions, but they tend to discourage the store department from carrying any large amount of stock. The mechanical department is also responsible for the great number of parts which the store is compelled to carry in order to supply the different styles and types of equipment, such as air brakes, injectors, safety valves and lubricator parts. Would it not be far cheaper to scrap the obsolete equipment, replacing it with standard material that will give better results and reduce the number of repair parts to be carried in stock?

We must check over our material and equipment, eliminating where possible, and we must bear this in mind at all times, not go over them once and then sit back and imagine that the job has been completed. It never will be as long as we operate railroads.

Another very expensive practice is the robbing of material from one engine for another. We not only pay for removing and replacing the part removed, but the chances are that it will cost more to apply the piece removed than it would to apply a new one. If each one of these items were traced down it will be found that if some one, whoever he may be, had been on the job it would not have been necessary. What per cent of the material we use does not give us the expected service because of other conditions? For instance, we will pack a piston rod half a dozen times, never getting it tight on account of an imperfect rod or the guides not going properly lined. If we had found out where the trouble was in the first place and corrected it we might have saved five sets of packing and the cost of applying them. This applies to many items used on our locomotives.

Material where carried in stock by the store should not be ordered before it is to be applied, especially small finished parts, as they will be thrown around and either broken or lost, necessitating ordering another piece which will double the cost. Shop people should be familiar with the cost of the different items of material they use. It is surprising to many good railroad men when they learn just what many small items really do cost, and probably they would think twice before saying, "Oh, throw it away and put on a new one."

An item of material where the quality has a great deal to do with the cost is the paint for locomotives. No matter how carefully or how scientifically it is applied, poor paint will not give good results and will have to be renewed much oftener than a coat of good paint. We are not painting our locomotives, especially our freight engines, merely to beautify them, but to preserve the material. An old coat of good paint is much better than a new coat of poor paint.

We should be far more efficient in the handling of material than labor, as the human element is not a factor to any great extent. If we watched more carefully the things we scrap there would not be so much material to reclaim. The more lax we are in scrapping material the better showing the reclaiming plant can make.

Manufacturing Locomotive Parts

The use of forging machines in our blacksmith shop certainly has worked wonders in producing forgings requiring very little or no finish, such as small side rods, eccentric rods, motion work, spring hangers and yokes, large hex nuts and other like material. I believe the blacksmiths take a great deal more pride today in doing their work so as to eliminate finish. For example, in main and side rods, the center sections are forged to size, requiring no finish except where the rods are channeled. Guide blocks should also be forged requiring no finish except where they fit on the cylinder head and one face for the guides and yoke. Guides also should be forged so as to eliminate as much finish as possible. Parts such as piston rods and valve stems should be cut to the proper length. Wedge bolts should be forged and the ends squared, so all that is necessary to complete them is to thread them in a bolt cutter. These were formerly made from bar stock on turret machines. Eccentric blade forks and ends and jaws for other motion work should be made allowing finish only where they fit on the links. Outside contours may be ground off. Eccentric blades for outside valve gears should be forged, allowing finish only on the sides, on the back end and for link fit on the front end. Large hex nuts and castle nuts should be forged and the holes punched, allowing very little finish. There are many other items where finishing can be reduced or eliminated if we only look for them, as the less number of operations necessary to produce a finished part the less the cost will be. Dies for this work are very expensive and should be taken care of, but they will pay for themselves many times over.

Castings

Patterns should be changed to reduce or eliminate finish where possible and changed from brass to cast iron or steel, or from cast iron to steel where parts are apt to break. If it is absolutely necessary to use brass, use it; if not, use either cast iron or steel. We are using many castings in the rough today which a few years ago we thought necessary to finish all over, such as side rod collars, wedge blocks and collars for main rods and strap middle connections, as well as many other small castings. On parts such as cast iron piston heads, allow finish only on the outside for cylinder size and the inside for the rod fit. Cast front cylinder and valve chamber heads with finish for the joint only. Core as many holes as possible and cast oil grooves in driving box brasses to save the time required to chip them. Core slots in driving box wedges for wedge bolts to size and maintain one standard for all wedges. All grate, side and center bars and supports, ash pan and grate shaker rigging castings, castings for tanks and front ends, cylinder cock and whistle rigging castings should be cast ready to apply on engines, with all holes cored and all castings the proper size and shape. The use of metal patterns is a help in securing good castings of the proper size and shape, as they will not warp or twist out of shape. Eliminate as much as possible finish on whistles, cab fixtures, blow-off cocks, boiler checks, cylinder cocks and valves, bells and yokes, relief valves, parts for piston and valve stem

packing, oil cups, swab holders, grease cups and plugs. Many of these items are used in large quantities and every little saving you can make will help to reduce our cost.

Where it is necessary to finish castings or forgings, be sure to allow enough finish, as it is much cheaper to remove 1/8 in. than merely to scrape off the sand or scale.

Reclaiming Material

We have made wonderful progress in the last few years in reclaiming material. Although it will not be so noticeable in the next few years, the results will be as good if not better, as we are making a more careful study of the things which might be reclaimed and other places where we can use material which has been reclaimed. We are also making many special machines, such as rattlers for cleaning nuts and other small material, cutting shears and machines for straightening iron, special tools for cutting gaskets and washers from old leather and rubber. The electric and acetylene welders have also worked wonders in reclamation. Most of this material is reclaimed after reaching the scrap dock and is handled in most cases by a special reclamation department. There is another side to reclamation which is not so often heard of. This is the reclaiming of broken parts on locomotives without removing them or by removing, reclaiming and replacing on the same engine they were removed from. In most cases this is done either with the electric or acetylene welders.

There is very often a close margin between the cost of reclaiming a piece and purchasing and applying a new one. In these cases we should apply the new piece, as too often in figuring the amount which we save we try to make the figures look as attractive as possible without taking into consideration the life or wearing qualities of the reclaimed piece as compared with a new one. We must guard against letting our enthusiasm get the best of our good judgment. I venture to say that there are many parts being reclaimed today at a loss in dollars and cents in the long run; it is the cost per mile that tells the tale—both in material and labor. Other cases will actually show a great saving. One which recently came to my attention was a 10-wheel engine with a main wheel loose on the axle. The wheels were removed and the loose wheel pressed off. The wheel fit, which was 8½ in. in diameter, was built up with the electric welder and turned off to 8⅝ in., the wheel bored to fit and the old key way used in remounting. Boxes and eccentric straps were replaced, the wheels put up and the engine was ready for service in a very short time, saving not only a new axle but many hours of labor.

Where parts such as piston rods, valve stems and other like material have been reclaimed by building up for fits, they should be properly annealed before being turned to fit. Where rods or stems are worn close to the scrapping limit, or to the age limit if we have one, it is not advisable to reclaim them.

The practice of welding small broken cast iron parts which in the first place do not require much finish is not worth the chances you take of not getting a good weld. In many cases a new part will be just as cheap and much better.

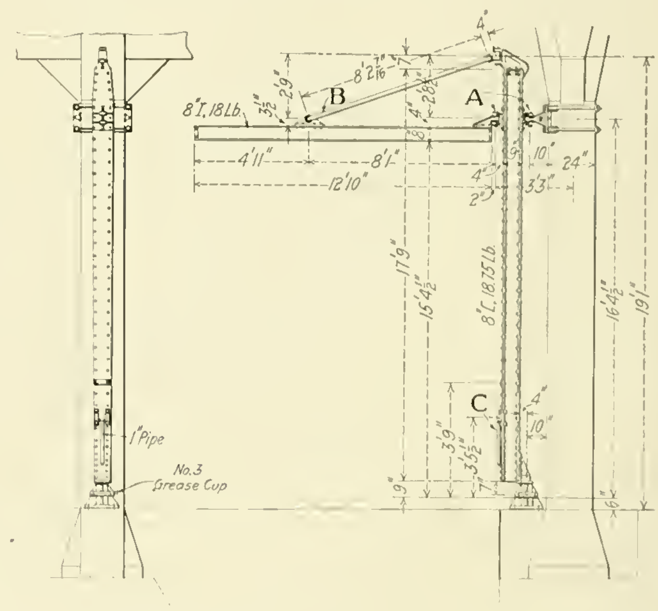
As I look back through the years that I have been employed by various railroads I can plainly note the progress year by year, made possible both by more modern machines and tools and by improving our methods of doing work. Still our progress has not kept pace with the development of locomotives, which are now not only much larger but are equipped with modern appliances such as mechanical stokers, superheaters, feed water heaters, brick arches and power-reverse gears, all adding to the cost of maintenance. There is no comparison between the cost of repairing engines today and a few years ago. The average cost has increased year by year, but let us hope that by our united efforts we may make it possible by more efficient methods to stop the upward trend of this cost, as this is necessary before we can reduce it.

JIB CRANE FOR ENGINEHOUSE COLUMNS

BY NORMAN McLEOD

The problem of designing an efficient form of crane for facilitating the work around the front end of locomotives in engine houses has attracted the attention of motive power engineers for some time. It is believed that the defects in cranes of this class previously designed and illustrated in the *Railway Mechanical Engineer* have been largely overcome in a 4,000-lb. capacity jib crane which has recently been designed and is shown in the sketch.

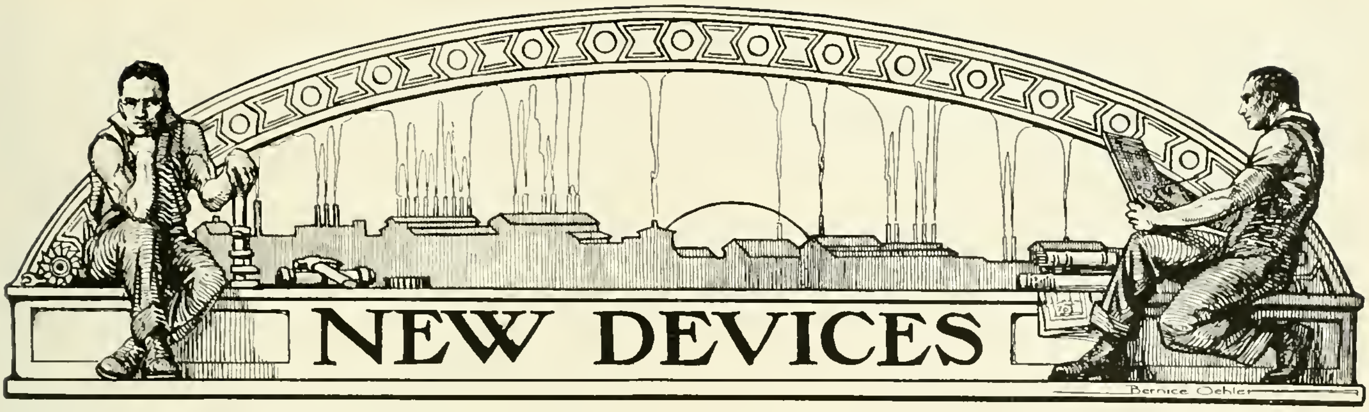
This crane is so designed that by the employment of a compound or toggle joint as shown at *A*, the jib is allowed to travel the full circle of 360 deg., which gives this crane an obvious advantage over cranes having a lesser radius. Sudden shock and strains on the column are greatly reduced by



Jib Crane With Toggle Joint Support

having the bottom trunnion and its supporting bearing entirely free from the column and supported on a concrete foundation independent of the column. The location and fastening of the tie bars *B* allow the maximum travel of the hoist, which runs on the lower flanges of the 8-in. I-beam. When supported by a wooden post, the elasticity of the wooden column cannot cause this crane to get out of alinement to the extent of causing the bearings to bind as may happen with the usual type of jib crane. Provision is made for turning the crane in the swinging 1-in. wrought iron pipe hinged at *C*. The entire crane is made of structural steel with special castings as is shown in the drawing and requires no further description.

Sixty-Year-Old Powder Car.—The Nashville, Chattanooga & St. Louis which operates through a section of the country that figured prominently in Civil war annals has in service a car which is stated to have been used during the Civil war. It is a box car and was used for the transportation of explosives by the Union armies in their operations around Chattanooga and Atlanta and appears to have had an adventurous career. As an active agent in the war its work was brought to an end when it was dumped into the Etowah river by the Confederate general, Hood. It was, however, fished up and in due course was adapted as an express and baggage car. It has been in more or less continuous service and recently has been used on construction.



Refrigerator Car Gas Eliminating System

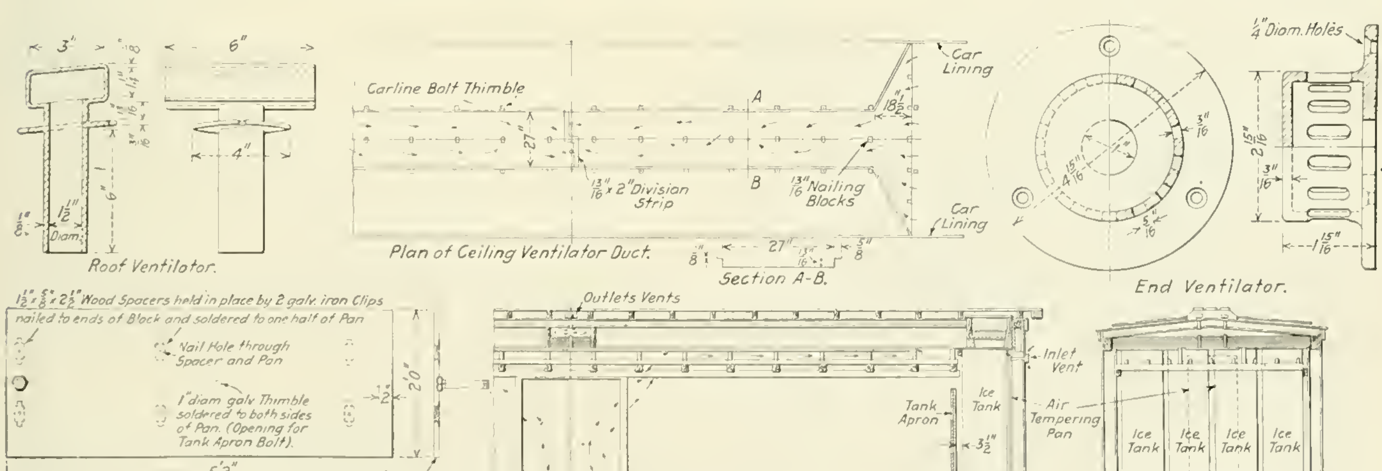
A SYSTEM for facilitating proper refrigeration of meat, vegetables or other substances subject to decomposition under ordinary atmospheric conditions, which is applicable alike to large or small ice boxes as well as to refrigerator cars, has been developed and is now controlled by the Acme Refrigerator Corporation, Chicago. This system, known as the Clinton Refrigerating and Eliminating System, is not in the ordinary sense of the term a refrigerating system. Its function is to remove from the atmosphere of the refrigerator the gases produced by bacterial action in the breaking down of the tissues of the product under refrigeration, and it is designed for use with any cooling system.

In all living animals there are myriads of active bacteria both toxic and anti-toxic. As soon as life is extinct, however, all anti-toxic activity ceases while that of the toxic bacteria continues. Immediate chilling to a temperature below 40 deg. F. causes the activity of all acid producing bacteria to be suspended, with the result that the meat becomes coated with a firm serum film which will protect the product against the action of air-borne bacteria, provided the atmosphere surrounding the product is kept free from excessive moisture.

The action of bacteria on the product produces both heat and gas, the heat being removed by the circulation of the air over the cooling medium. The so-called tissue gas and other gaseous by-products resulting from bacterial activity, however, readily absorb moisture which is deposited against the cool surfaces of the product and the sides of the car. As a result of such condensation the car sweats and becomes moldy, and the moisture deposited on the surface of the product dissolves the serum film and increases the moisture content above the point at which the activity of all harmful bacteria is suspended. In the case of meats, the result is a slimy surface and an increased bacterial activity which breaks down and liquefies the solid protein material with the production of the acids CH_3SH and H_2S, both of which have disagreeable odors. Essentially the action is the same in the case of vegetable products.

The design of the Clinton Eliminating System is based on the principle that it is necessary to remove from the car the bacterial produced gases without lessening the efficiency of the refrigeration and circulation of the atmosphere within the car. The removal of these gases with their high moisture content produces a dry, clean atmosphere, the condition least favorable for bacterial activity and hence most favorable for the preservation of perishable products.

The gases produced by bacterial action, due to their difference in density as compared with the air, tend to stratify in the upper part of the car close to the ceiling, and the eliminating system makes use of this difference in density as the propelling force to remove these gases and replace



Details of the Clinton Gas Eliminating System

them with air from outside the car. The gases are collected in a shallow duct 13/16 in. deep, located just below the ceiling and open for the full width of the car near its ends. The duct is divided into two parts near the longitudinal centerline of the car, from each of which an outlet vent is led through the roof, the tops of the vents being located under the running board. These vents have an inside diameter of 1½ in. and their continuity is broken in a chamber between the ceiling insulation and the roof of the car.

In order to effect the elimination of the gases collecting in this duct, provision must be made for drawing in an equivalent amount of fresh air. This is done through inlet vents in the ends of the car opening into thin air-tempering pans which are placed in the space between the end lining and the ice tanks. In the drawing these are shown to be 5 ft. 2 in. long by 2 ft. wide, and are only ¾ in. deep. The vents through the ends of the car open into the pans near the top and the pre-cooled air is admitted to the car through openings just above the bottom on the sides facing the ice tank. The air is thus cool and dry before it enters circulation in the car. The amount of air admitted is only sufficient to replace the weight of the lighter gases collecting in the top of the car and passing out through the outlet vents. As these gases are not only heavily charged with moisture but carry a considerable amount of heat resulting from bacterial action, the ease with which the proper conditions of refrigeration may be maintained is considered to be more than an offset for the amount of heat which must be removed from the replacement air.

As an inspection of the drawing will show, the Clinton Eliminating System consists essentially of but two parts, the gas collecting duct attached to the ceiling of the car and the ice tempering pans which are attached to the end lining of the car and occupy a portion of the space between the lining and the ice tanks. It will be seen that the system may, therefore, readily be installed in existing refrigerator cars with only minor alterations in the car structure to accommodate the inlet and outlet vents.

This system has been installed in a number of cars of the Cudahy Refrigerator Line. The service of this equipment during the last hot season was satisfactory in that it has demonstrated the correctness of the principle of the system as a means of greatly reducing the rate of decomposition of perishable products, and more cars are to be equipped.

Combustion Recorder for Flue Gases

It is a well known fact that the proportion of carbon dioxide (CO_2) alone in flue gases is not a sufficient indication of efficient boiler operation. This is true because the correct proportion of CO_2 varies with the kind of fuel used, the method of firing, the amount of air admitted, etc. For example, a proportion of 15 per cent of CO_2 might be allowable in one boiler installation, whereas another

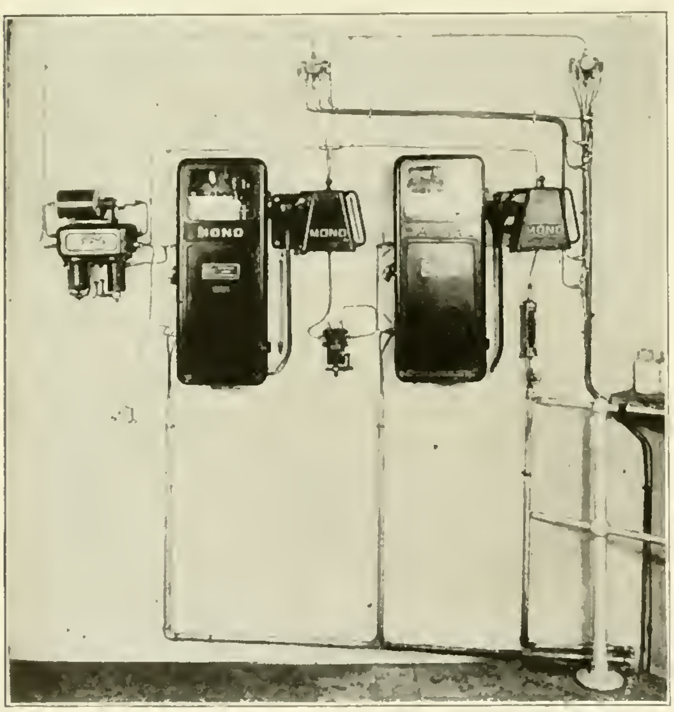


Fig. 1—Installation of CO_2 and CO Combustion Recorder in Boiler Room

boiler, using a different kind of coal, would be operated most efficiently with a lower percentage of CO_2.

The presence of any carbon monoxide (CO) is an indication of inefficient boiler operation and the best way to be sure no CO is going up the stack is to measure it, simultaneously with CO_2. A combustion recorder that measures both CO_2 and CO has been developed by the Mono Corporation of America, Buffalo, N. Y., and is illustrated in Fig. 1. With the use of this recorder it is impossible for the boiler room force so to manipulate the dampers that a high CO_2 reading is obtained without showing up at the same time a high proportion of CO. The fuel must be so burned that the

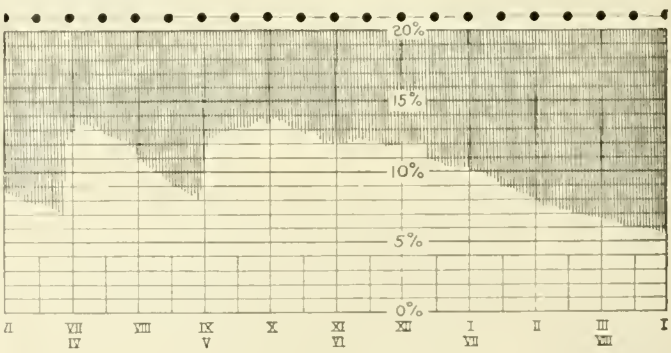


Fig. 2—Chart Showing Percent of CO_2 in Flue Gases

percentage of CO_2 is as high as possible without showing up any CO. In this way complete combustion is effected.

The device shown at the left of Fig. 1 is called the monoxide auxiliary type K, which, coupled with the stand-

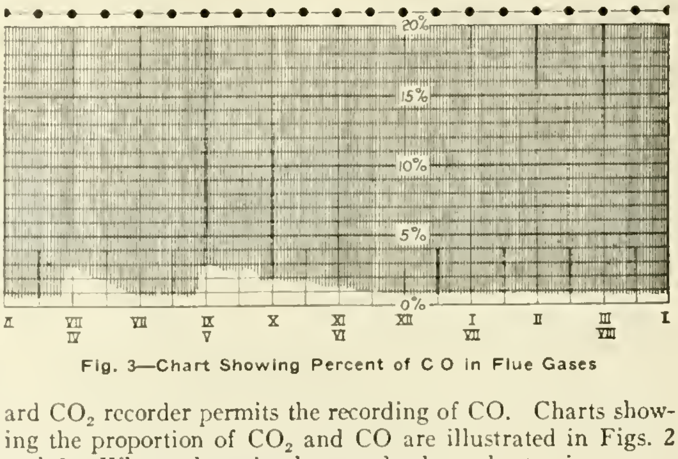
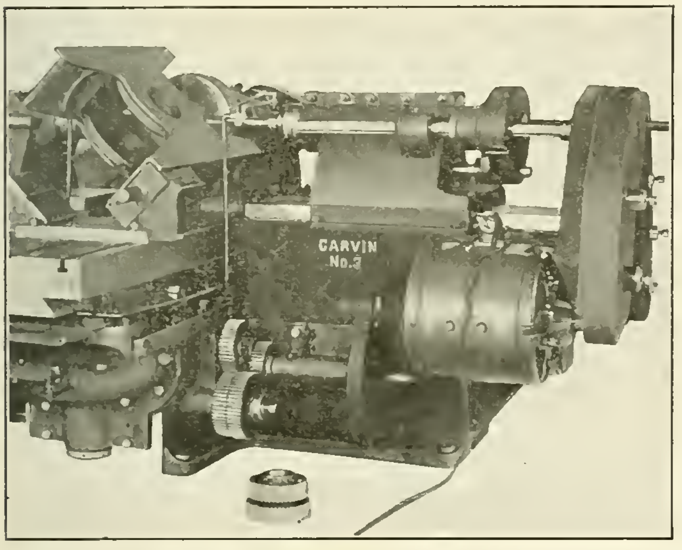


Fig. 3—Chart Showing Percent of CO in Flue Gases

ard CO_2 recorder permits the recording of CO. Charts showing the proportion of CO_2 and CO are illustrated in Figs. 2 and 3. When taken simultaneously these charts give an accurate account of furnace conditions.

Machine for Milling Crosshead Keyways

A MACHINE designed to mill the keyways in all classes of locomotive crossheads and piston rods, has been placed on the market recently by the Garvin Machine Company, New York. The two keyway slots in a steel crosshead vary in size up to 1⅞-in. wide by 4⅞-in. long by 5 in. deep and the difficult job of machining them is readily accomplished on the machine illustrated at the rate of one crosshead per hour. A 5½-in. piston rod keyway can be machined in one hour also, as has been demonstrated on one of these machines installed in a large railway shop in the east. With piston rods, the work is swung around at an angle to provide the necessary taper; and when the slot is nearly through, one cutter automatically retreats and the other continues to advance, completes the slot and then stops feeding. The work moves and the cutters are fed in from each side.

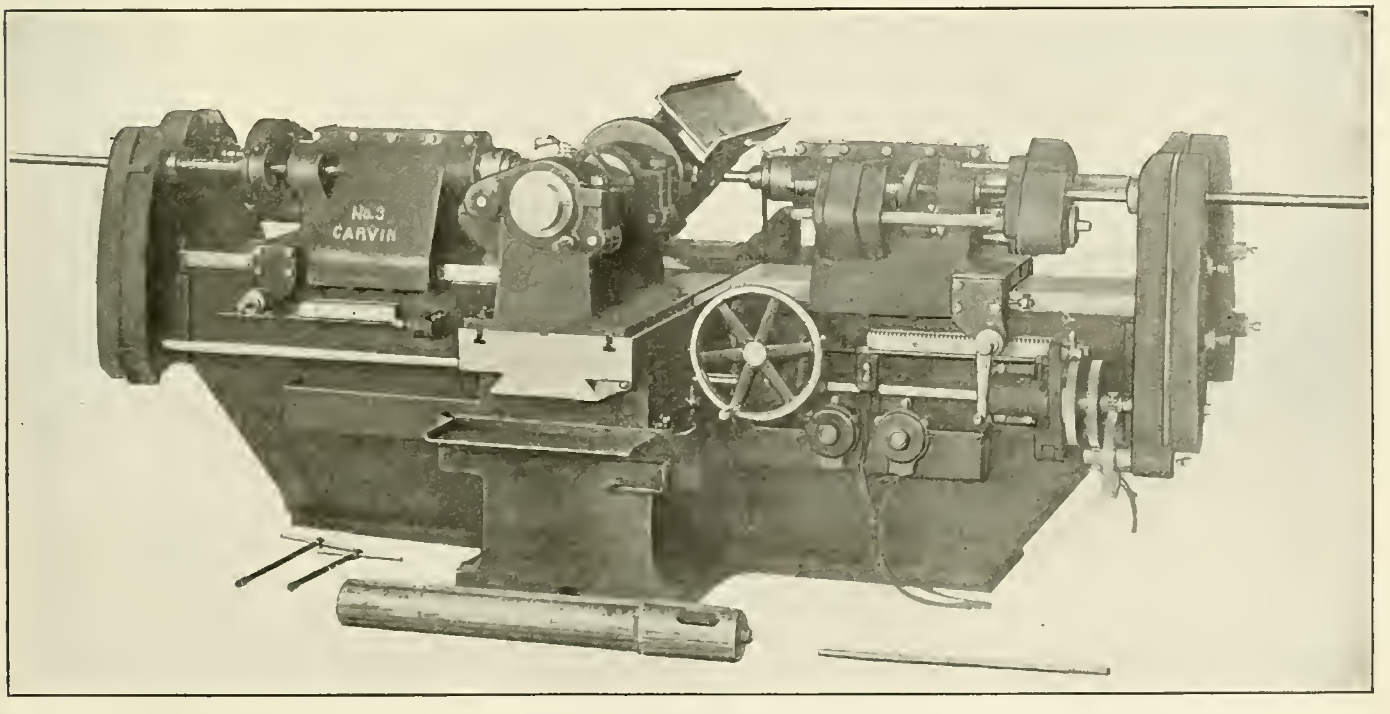


Rear View Showing Motor Drive, Change Gears and Angular Positioning Block

A fixture is provided to hold the crosshead on a mandrel, as illustrated, with some adjustment lengthwise, and a rear block to register the angular position of the keyway with the guide ways. The same fixture is used for the piston rod, but with a diagonal tongue piece to give the required taper. This fixture is used for all sizes by bushing down. The work is mounted on a heavy table and traversed by an adjustable crank pin and block, both hardened, moving in a hardened slot carried on the bottom side of the table. The crank stands vertically and is driven by a large bronze worm gear running in oil.

The cutters are held in two sliding sleeves carried on adjustable headstocks fitted to the bed. The heads can be run back to get the cutters out of the way when mounting the work, and then run forward to fixed stops. Each sleeve has a maximum feed of six inches and an automatic trip. The cutter sleeves are run forward and back simultaneously by hand, by a large handwheel at the front. The cutter spindles are fitted with positive driver slots for cutters and the front bearing is tapered, running in a solid bronze box. The rear bearing is straight, fitted with an adjustable bronze box.

The bearings of the sleeves in the heads are split the whole length to regulate the tightness of the sliding fit. The in-feed of the cutters takes place at each end of the stroke, and varies from .010 in. to .025 in. by an adjustable pawl and ratchet. An automatic trip is provided to lift the pawl out of action and stop the feed of the cutters when the proper depth is reached. The machine is driven by two five-horsepower, three to one variable speed motors with push button control, arranged so that if one motor fails the other will stop. All feeds and drives are positive except the oil pump. The adjustable crank for moving the table can be adjusted by a wrench at the rear and set by a scale on the moving table.



Garvin No. 3 Duplex Slot-Milling Machine

Change gearing is provided to regulate the number of

strokes per minute of the table in relation to the length of slot and diameter of cutter being used. The cutters run 70 ft. a minute, with a maximum in-feed of .020 in. on large cutters, two-prong fish-tail cutters being used. The table moves at the rate of 18 in. per minute at mid-stroke. For milling a through slot as in a piston rod, the right-hand head carries a special screw that can be thrown into action, and this screw advances towards the right at the same time that the sleeve feed screw is advancing towards the left. At the proper time the feed nut of the sleeve screw is unlatched and the special screw meets the feed screw head, pushing the feed screw and spindle sleeve back bodily; while the left-hand cutter continues to advance. When the left-hand cutter has cleaned up the slot the automatic trip lifts the feed pawl out of action. The feed nut is relatched and the cutters resume their original positions, when the cutters are run back by hand.

A strong stream of lubricant to wash the chips out of the slot is provided for each cutter with a necessary oil trough and reservoir. Intermediate cloth gears are used to reduce noise and all gearing is thoroughly protected. The method here used of light cuts and fast traverse is more rapid than heavy cuts and slow feed, and is not limited so much by the depth of cut. The machine can be used for cutting keyways, cutting out fork ends in rods and other work of a similar nature.

Laminated Glass for Car Windows

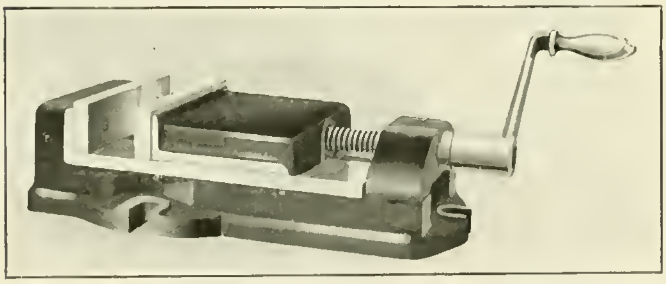
A NEW type of laminated safety glass has been invented recently and placed on the market by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. This glass consists of two sheets of ordinary glass, between which is interposed a thin sheet of pyroxylin plastic. Hydraulic pressure and the application of the proper degree of heat welds the glass and the pyroxylin sheet together in a solid unit. The pyroxylin binder prevents any scattering of fragments in the event of violent breakage of the glass.

In a recent test, a nickel jacketed revolver bullet fired from a distance of seven feet failed to penetrate a sheet of this laminated glass. The transparency of the glass, it is claimed, is not appreciably reduced by the insertion of the plastic sheet. It is proposed to introduce the glass extensively for use in car windows or wherever fragments of broken glass will cause personal injury, should a window be broken either accidentally, or maliciously, as by small boys throwing stones.

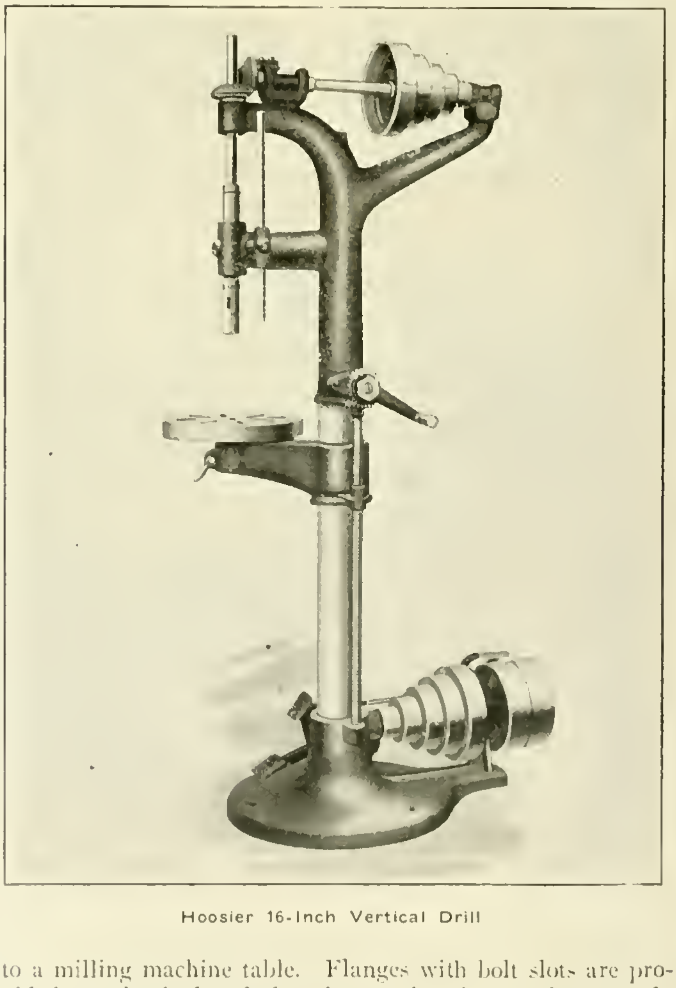
Hoosier Plain Drilling Machine and Vise

A 16-IN. plain drive vertical drilling machine designed for light and medium work has been developed by the Hoosier Drilling Machine Company, Goshen, Ind. Maximum simplicity together with convenient operation has been secured in this machine. All gears are machined and carefully fitted. Particular attention has been paid to the spindle alinement and to securing ample lubrication of all bearing surfaces. The drill is driven by a belt from the main shafting and is started and stopped by means of a foot-operated belt shifter. Cone pulleys provide a range of five spindle speeds. Either a round or square table can be provided.

It is possible to drill to the center of a 16-in. circle, the distance from the column to the center of the spindle being eight inches. The maximum distance from the spindle to the table is $28\frac{3}{4}$ in. and from the spindle to the base $44\frac{3}{4}$ in. The spindle travel is $8\frac{1}{2}$ in. The machine consumes about one horsepower and the speed of the driving pulley should be approximately 300 r.p.m. This allows a range of spindle speeds including 46, 172, 300, 521 and 971 r.p.m.



An Adaptable Vise of Rugged Construction



Hoosier 16-Inch Vertical Drill

Detachable Vise

The vise illustrated is intended for use on drilling and milling machines, but can be used with equal success on shapers or planers. Like the vertical drill described above, the vise is simple in construction and strong. The jaws are faced with hardened steel. On the bottom of the vise body a milled key slot runs the entire length of the body and insures correct alinement when the vise is anchored to a milling machine table. Flanges with bolt slots are provided on the body of the vise so that it may be securely anchored to the table.

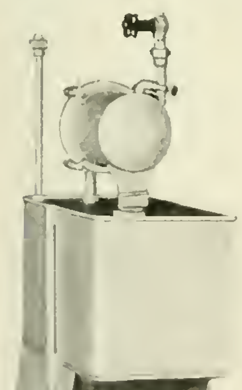
North Pole Sanitary Drinking Fountains

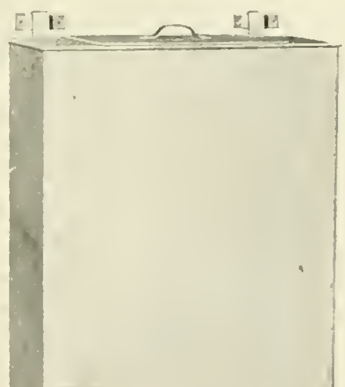
The Henry Giessel Company, Chicago, Ill., has developed and placed on the market several types of drinking fountains that have proved to be a sanitary and economical part of railway equipment. These fountains are of very substantial construction, effect a considerable saving in

Special Cooler for Locomotive Tenders

the amount of ice used and require only a minimum of attention at terminals.

There are several designs of this fountain for use in passenger carrying equipment, one of the latest types being shown in the illustrations. The fountain for passenger



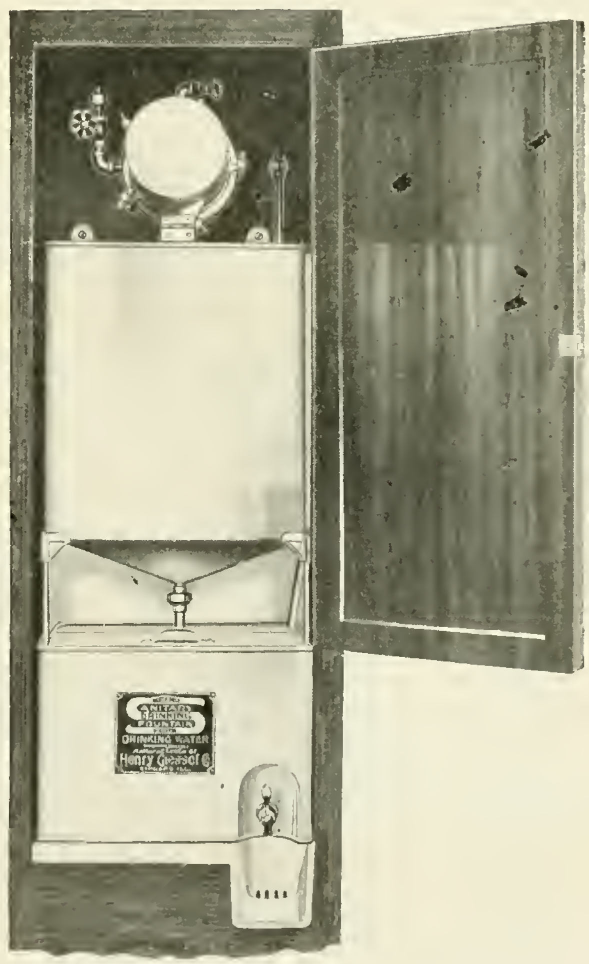


Fountain for Mail Cars Type Used in Baggage and Express Cars

coaches consists of a filter, shown at the top, a storage tank having a capacity of seventeen gallons and an ice chamber containing a cooling pan with a capacity of three cups so that only the water that is being used is cooled, thus effecting a great saving in the amount of ice required.

A fountain designed for use in mail cars which is made with or without a filtering apparatus is also shown and, being similar in construction to that used for passenger coaches, furnishes the employees of the railway mail service with sanitary drinking water. The fountain proper consists of a storage tank for filtered water and an ice compartment in the bottom of which is placed the cooling pan through which the water flows from the storage tank to the faucet. The water supply is drawn from the overhead tank of the car and, by gravity, passes through the filter on the top of the fountain into the storage tank and thence into the cooling tank.

These fountains require no steaming or cleansing during



Porcelain Enameled Fountain for Passenger Coaches

train operation as all that is necessary is to change the filter stones at terminals every seventy-two hours, simply replacing the stones with freshly sterilized ones. This operation requires only about ten minutes per car, the thorough cleansing and sterilizing of the entire apparatus being necessary only at infrequent intervals as the use of freshly sterilized filter stones meets all of the sanitary regulations in the various states and has been favorably passed upon by the United States Board of Health. However, provision is made for convenient and thorough cleaning of all parts of the cooler. By the removal of five clamps, the filter casing may be removed and the filter stone taken out by unscrewing the pipe connection with which it is attached to the fixed end of the filter case. It is then easily and thoroughly cleaned by steam or by submerging in hot water. An opening is provided on

the front of the storage tank near the bottom which is closed by a plug. Removal of this plug permits the interior of the tank to be cleaned by the insertion of a steam nozzle.

To drain the system, a cock is opened in the bottom of the cooling tank which permits the water in the storage tank to flow directly into the ice chamber and thus out through the drain.

An adaptation of this fountain for baggage, express and other cars where drinking water may be required is also shown which, in addition to the supply of drinking water, provides a tank for wash water.

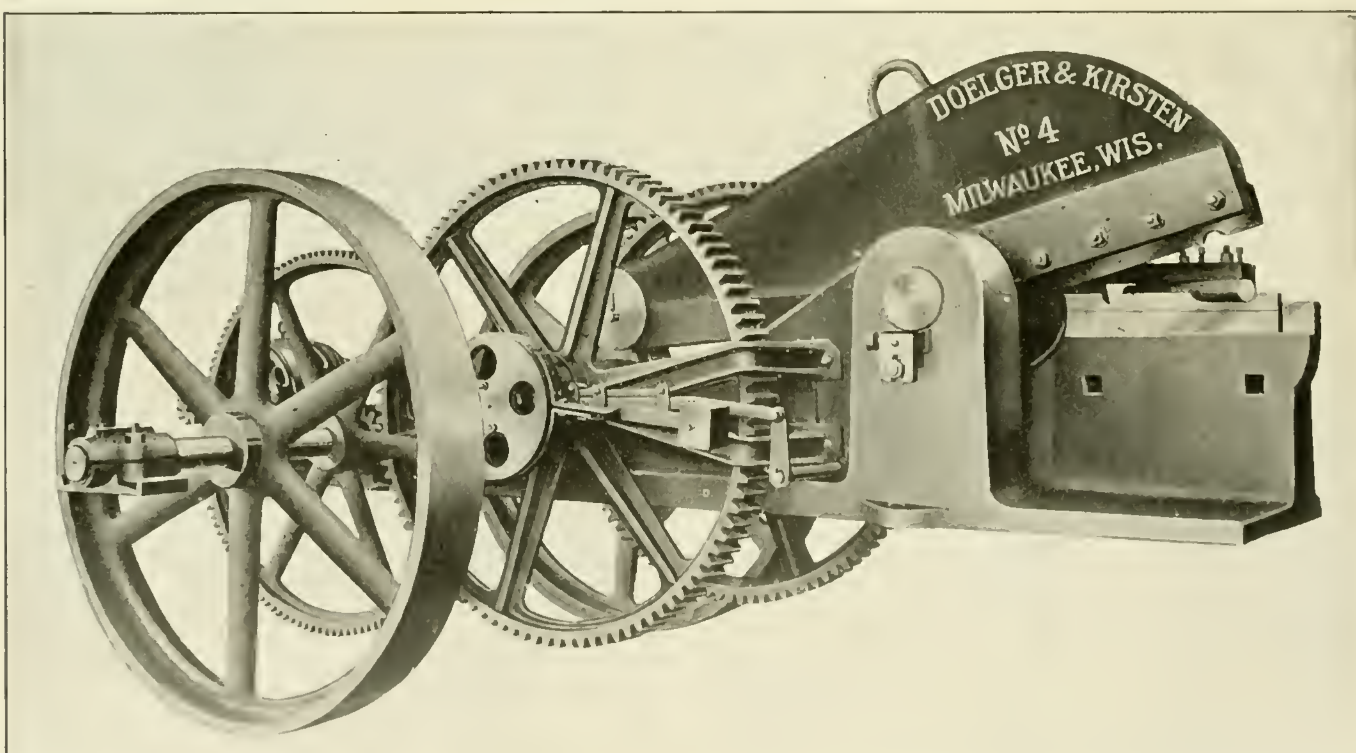
In addition to the three tanks already mentioned, this company also manufactures a portable tank for locomotive tenders. This tank has an ice compartment as in the other fountains and thus provides pure water without contamination from ice which may be secured from sources where it is impossible to eliminate cinders or other impurities. In this tank, the melted ice drains off and, as only a small portion of the water is in contact with the ice at any one time, the economy of the cooler is apparent. As shown in the illustration, a bracket is permanently attached to the tender and sockets are provided on the tank so that it may be securely suspended from the bracket and thus withstand the shocks incident to the operation of the locomotive.

A filter operating in a manner similar to the filter used with these fountains, is manufactured by the Giessel Company for use in conjunction with the Giessel standard cooling pan and makes a complete filtering and cooling apparatus for dining cars. These filters and fountains are in use on a large number of railroad cars on a number of the larger railroads in the United States and observations made by two of the largest roads show that twenty-five pounds of ice is sufficient for a run of five hundred miles. These fountains are made of cast iron, white porcelain enameled, are easily kept clean and add to the interior finish of a car. They are economical in the use of ice.

Alligator Shears for General Work

A LINE of alligator type shears which can be used to good advantage in railway blacksmith shops, scrap docks and reclamation plants, has been developed and introduced recently by Doelger and Kirsten, Milwaukee, Wisconsin. The machines are made in four sizes with jaws varying from 21 to 30 in. long and bar stock up to 5 in. square can be cut on the No. 4 shears. The machine, illustrated, is exceptionally rugged in construction and designed to withstand all stresses incident to the severe nature of the work performed.

An important feature in the construction of this line of alligator shears is found in the automatic attachment by means of which the operation of a foot lever trips the clutch and causes a full stroke, the machine stopping automatically at the end of the revolution. The work may be fed to the shears from either side and it is possible to cut boiler plate as well as bar stock. Large gears on both sides of the crank shaft, are used as drive gears and their size and weight insures a strong, well balanced drive. The automatic arrangement by which the machine stops at each stroke, allows sufficient time for careful measurement of the work before the machine is again operated.



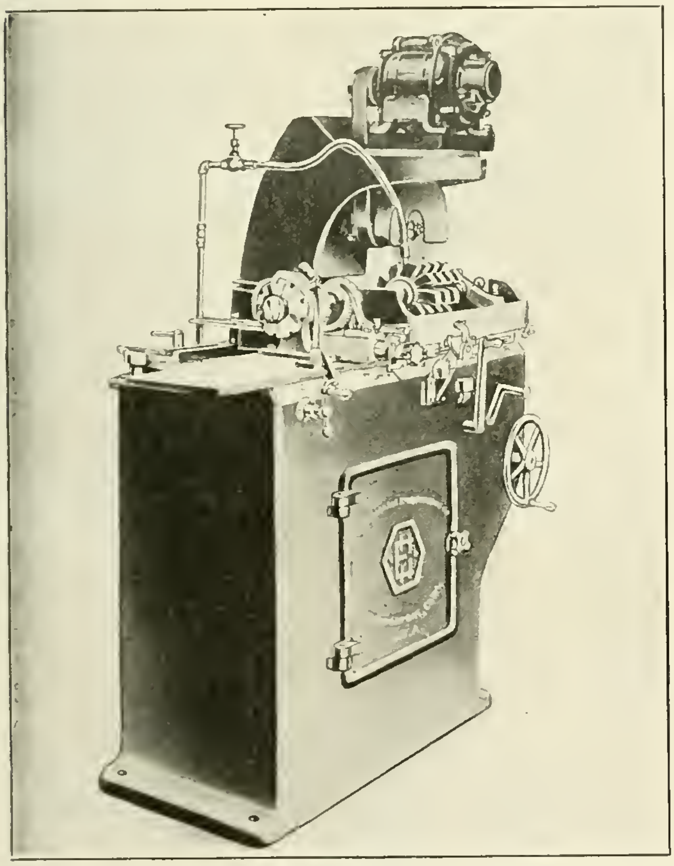
Alligator Shears Cut Round Stock at an Angle Without Deformation

Particular attention is called to the arrangement by which round stock can be cut at any angle up to 30 degrees. This feature is of value for many operations as, for example, in the manufacture of chain links. Doelger and Kirsten No. 4 alligator shears have been installed at one plant to cut 5½ inch round iron bars at a 30 degree angle in making chain links. In this case, a clean cut surface for welding is secured and no loss of time occurs due to the blacksmith form-

ing the 30 degree angle on each link by hand. Cutting the stock at any angle is made possible by the use of suitable dies. The dies required depend upon the kind of work desired to be done and they are essential particularly in cutting round stock. With the dies, it is possible to cut round stock well within 5 per cent of the perpendicular and the end of the stock is not deformed. This feature is particularly valuable for certain kinds of work.

Motor-Driven Automatic Hob Grinder

THE latest addition included in the line of precision grinding machines manufactured by the H. E. Harris Engineering Company, Bridgeport, Conn., is an automatic hob grinder. This machine is furnished either as a belt- or motor-driven machine, the former being called No. 815-B and the latter No. 815-M. On account of the many advantages of machines equipped with unit motor drive the No. 815-M machine illustrated is a favorite with shop foremen and managers. It can be set up in the most convenient position, irrespective of shaft or group drive.



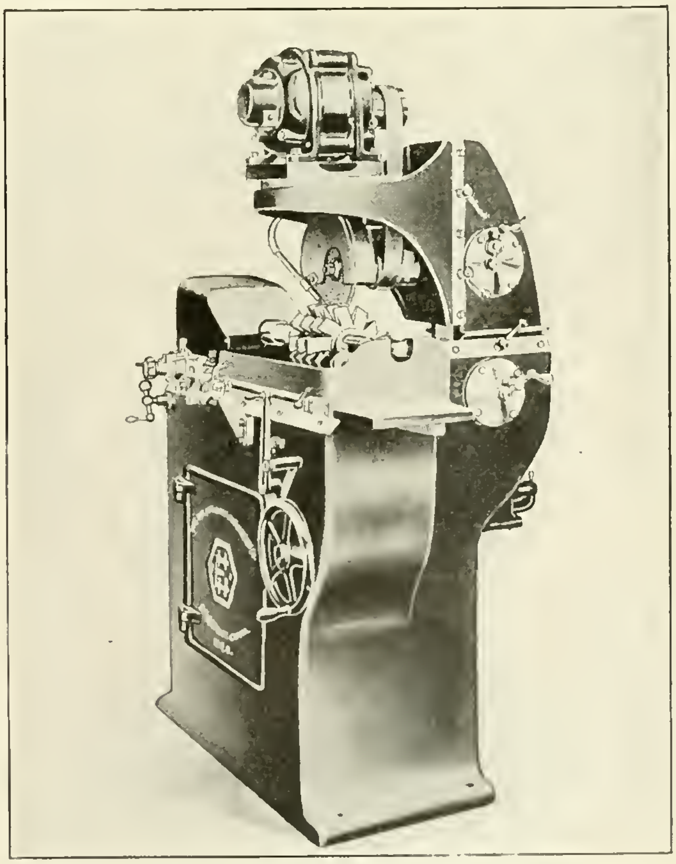
Harris Automatic Hob Grinder Arranged for Motor Drive

The motor for driving the wheel spindle is mounted above and upon a circular horizontal slide, the wheel head being mounted below on the same slide. The drive from motor spindle to wheel spindle is by an endless belt, the slack being taken up by raising the motor itself. This motor does no work except to drive the spindle and sudden torques from reversing or indexing do not affect it. The cutting face of the grinding wheel coincides with the vertical axis of the horizontal circular slide, so that when this slide is swiveled to the desired angle of the hob flute, the wheel is in the correct position. The weight of the motor adds to the stability of the machine and helps in absorbing vibration. Better results can be secured with this type than with the belt-driven machine. The ball crank handles, shown on the right of the column, control a fine and powerful vertical and horizontal adjustment to the wheel head.

For driving the automatic slack take-up device, the indexing mechanism, the self-priming pump and the table feed and reverse, a separate motor is located behind the machine base. The machine is provided with full automatic features throughout, including indexing, reversing, feeding the hob a predetermined amount after each revolution, and stopping when the desired amount has been ground off.

Hobs not exceeding 8 in. in diameter by 10 in. long can be ground. It makes no difference whether the flutes are straight or spiral, both right and left hand spindles being taken care of by the ball crank handle on the left of the machine. This controls a fine adjustment through worm gear, pinion and sector to the forming slide, which is coupled to the work spindle. The hob rotates the required amount to provide helical movement during the longitudinal movement of the work table. The adjustment can be made while the machine is running. Indexing is done automatically.

The table travel can be operated either by hand or automatically. The short lever on the extreme right controls the



View Showing Handles for Wheel Head Adjustment

automatic table feed and reverse mechanism. A diamond truing device is arranged for truing either side of the grinding wheel to any angle required, also the periphery of the wheel. It can be used without interfering with the set up of the hob or cutter in the machine.

After the hob has been set up and the machine started, an automatic adjustable feed is provided which will grind off the face of the teeth the required amount at each stroke. Provision also is made so that a predetermined amount may

be ground automatically through successive revolutions, when the machine stops automatically.

One unusual feature of the machine is an ingenious device providing a uniform pull to take up all slack in the spindle indexing and spiral generating mechanism. This permits the grinding wheel to operate on both strokes.

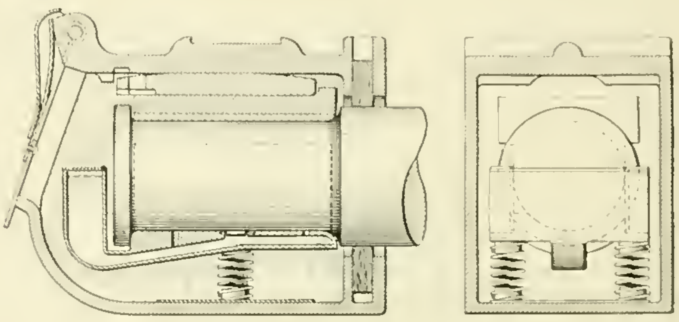
It is claimed that by the use of the Harris automatic hob grinder the life of hobs will be increased materially, for the cutting teeth are accurately and evenly ground, the minimum amount of material is ground away at each stroke, there is no crowding or burning of the hob teeth and the profile or temper of the teeth is not destroyed. An ample supply of cutting lubricant is furnished and provides greatly increased machine output when necessary.

Grease Lubricator for Journal Boxes

A DEVICE for holding and distributing hard grease to car journals has been developed for application to the standard journals and journal boxes in place of the usual oil soaked waste packing. It has been tried out successfully in passenger service.

The illustration shows the form of the lubricator and the method of applying it to the journal box. The lubricator consists of a brass casting, the grease reservoir extending up in front of the journal collar and the distributing surface being fitted to the under side of the journal bearing. It is held in place against the journal bearing by two coil springs, the upper ends of which fit over lugs on the bottom of the lubricator, while the lower ends are held in position over lugs on a plate, resting on the bottom of the journal box. In an opening in the face of the lubricator bearing against the journal is fitted a small roller which serves partially to distribute the grease to the journal surface. Grease is also fed to the journal through holes drilled through the bearing surface of the lubricator. The journal is protected from dirt by two pads attached to the sides of the lubricator, extending upward against the sides of the journal to the lower edges of the brass. These shields or pads also serve to hold and distribute the lubricant over the journal when it is in motion.

Like all grease lubrication, the operation of the device depends on a sufficient rise of temperature of the journal to soften the grease and permit it to flow freely. The reservoir opening, located in front of and at about the center of the



A Journal Box Lubricator Using Hard Grease

journal collar, is readily accessible for refilling by opening the journal box lid.

The patents on this device are owned by T. J. Holmes, Chicago.

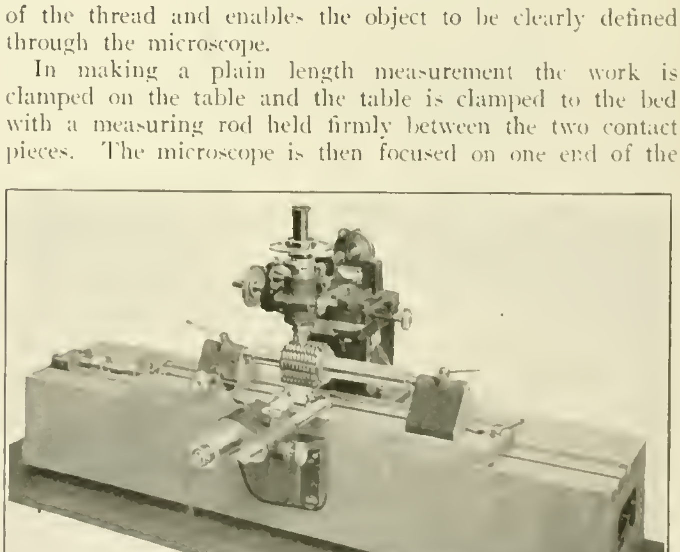
Screw Thread and Gage Checking Machine

CONVENIENT and accurate means for checking the measurement of screw thread tools, formed tools, gages, etc., is provided by a microscopic measuring machine which is being introduced to the American market by Alfred Herbert, Ltd., Coventry, England. The machine is well adapted for measuring lengths, angles and pitches. It does not depend on screws for its accuracy, but upon end measuring rods and large dial micrometers. It consists of two main parts, including a rigid box-bed carrying a table capable of 12-in. movement by accurate amounts through the insertion and removal of standard hardened steel measuring rods of known length between flat contact pieces. A pair of centers also is provided, one of which is adjustable in a crosswise direction to enable work to be lined up accurately.

The other part of the machine consists of a microscope with vertical movement by means of a rack and pinion for focusing, and mounted on a compound slide rest, with screw movement parallel with the slides and at right angles to the table slide. The microscope is fitted with two hair lines across its diameter, one rotating with the outside tool and the other rotating with the eyepiece. The outer tube carries a large dial, carefully graduated in half degrees, and the eyepiece carries a vernier, which enables readings accurate to one minute to be made. Thus the angle between the two hair line can be indicated with great accuracy.

A light projector is fixed to the machine to project parallel rays of light through a lens onto a mirror placed at an angle, and so past the work. When measuring threads this attachment eliminates all shadows and the light projected from the flanks of the thread which tend to make the object indistinct. The mirror is adjustable to suit the lead of the thread and enables the object to be clearly defined through the microscope.

In making a plain length measurement the work is clamped on the table and the table is clamped to the bed with a measuring rod held firmly between the two contact pieces. The microscope is then focused on one end of the



Herbert Microscopic Measuring Machine

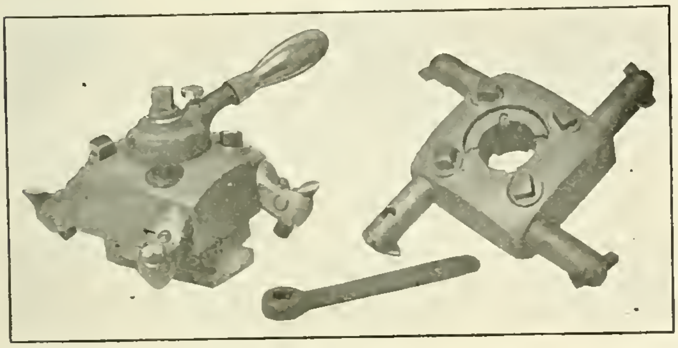
piece or part to be measured, with the hair lines covering a defined point from which the measurement will be made. The measuring rod is then substituted by another and the table adjusted and reclamped. By looking through the microscope it is quickly seen whether the part to be measured

corresponds with the difference between the lengths of the two measuring rods. If it varies, the compound slide can be adjusted until the hair lines cover the second point that should have come immediately under them if the part had been correct. The micrometer on the compound slide registers the error.

For the checking of gages, master templates, pitch, depth and shape of screw threads the machine illustrated is exceedingly accurate. All angles are checked by angular adjustment of the hair lines and irregular shapes are checked by a series of straight line measurements combined when necessary with adjustments of the hair lines.

Turret Tool Post for Engine Lathe

A TURRET tool post, designed to be used on engine lathes, has been produced recently by the Lovejoy Tool Company, Inc., Springfield, Vt. It is rigidly constructed, convenient in operation and compact enough to be used on any lathe having a center height above the tool rest of over 1⅜-in. A positive lock is incorporated in the turret. The turning and facing cutters are adjustable for height as they become worn; this feature permits of keeping the cutting edge on center without sacrificing strength and rigidity. The tool overhang has been reduced to a minimum.

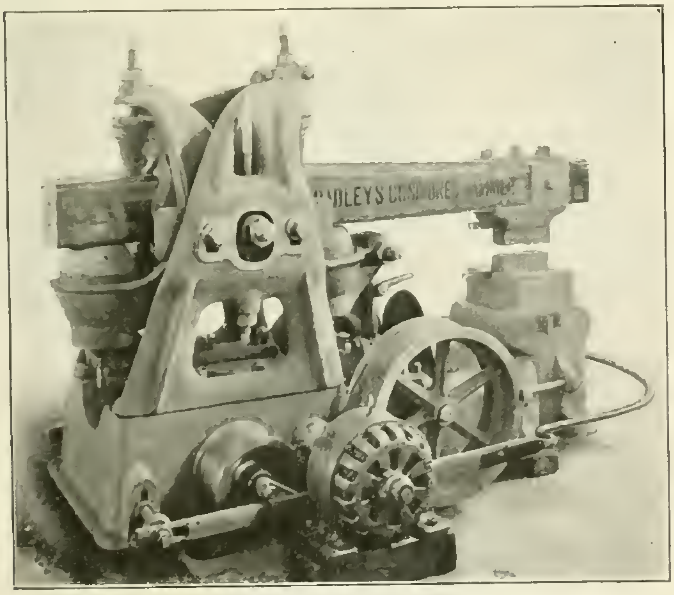


Lovejoy Turret Tool Post

By one movement of the binding lever the operator releases, accurately indexes to the next tool post, and again rigidly clamps the turret to its base, an operation quickly accomplished by one hand. The turret rings are approximately 4⅜ in. square, made of hardened steel and are interchangeable on any base. This feature permits the use of additional rings, carrying a variety of tool combinations for various jobs. One of the rings is provided with boring bars one inch in diameter as shown in the illustration. These are entirely free from projections to interfere with chip clearance and will cut to the bottom of a hole slightly larger than the bar itself. The toolpost will instantly interchange with any regular engine lathe toolpost without special fitting of the lathe. It is only necessary to submit dimensions of the toolpost saddle with the order.

Motor Drive Applied to Power Hammers

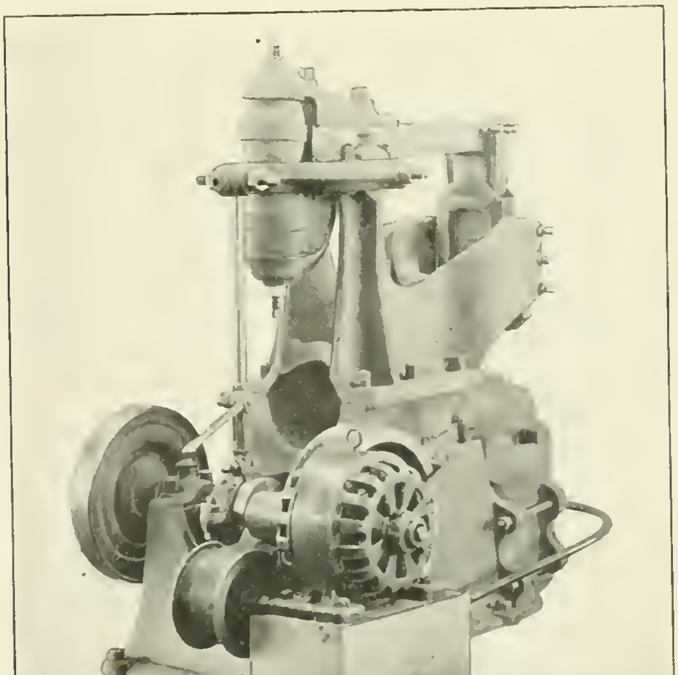
CONVENIENT arrangements of motor drive applied to the power hammers manufactured by C. C. Bradley & Son, Inc., Syracuse, N. Y., are shown in the illustrations. Where there is an objection to the use of overhead



Bradley Hammer With Driving Motor Mounted at the Side of the Machine

shafting or where the blacksmith shop is isolated from the main power plant this arrangement can be used to good advantage, a compact and efficient motor drive being secured.

The motor is mounted on a block adjacent to the machine and drives through a loose belt and idle pulley between the motor and hammer. Pressure on the foot treadle engages the idler and starts the hammer, also regulating the force



200-lb. Bradley Hammer With Driving Motor at the Rear

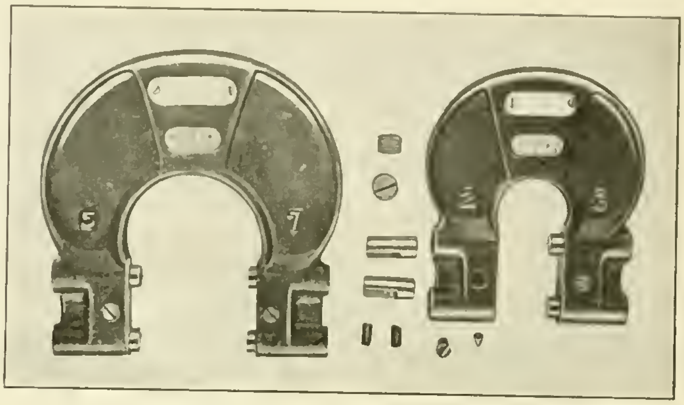
of the blow. On the 200-lb. hammer, a counterweight balances the idle pulley. This insures that practically all pressure applied to the foot treadle is transmitted to the idler.

Adjustable Limit Gage Aids Inspector

ONE of the latest gages produced by the John M. Rogers Works, Inc., Gloucester City, N. J., is the adjustable limit snap gage illustrated, which is convenient for accurate inspection work. Gages of this type are made in 22 different sizes, the smallest of which has a range of from 0 to ¼ in., while the largest has a range of from 8 to 8½ in. The frame of the gage is double ribbed to afford extreme rigidity, a most important feature in a tool of this kind. The anvils are made of alloy steel, hardened, ground and lapped to afford durability and accuracy. Marking tags showing the sizes are made in the form of separate brass plates screwed to the frames of the gages, and extra tags may be furnished when they are required.

Before being machined the malleable iron castings are well seasoned to guard against danger of warping after the gages have been finished. All of the gage plugs are carefully lapped, both on their diameters and gaging surfaces. This accuracy in sizing the diameters of the plugs enables them to fit snugly into the holes in the frame, which are line-reamed to assure parallelism. The plugs are so designed that they cannot turn in the frame. The adjusting screws have a fine pitch thread, which permits of making accurate adjustments. A master locking device in addition to firmly setting both anvils with one master screw can also be set to hold a slight tension equally on the anvils while adjustments are being made. When the master locking screw is firmly set the space provided over the head may be sealed, making the gage proof against tampering.

It is an easy matter to set the plugs to any dimension



Rogers Adjustable Limit Gage

within the range of the gage by using a standard measuring plug block, or disk. When the plugs become worn and require repairing it is only necessary to grind the ends on the wheel and lap the surfaces down perfectly square.

Crank Shaper With Wide Cross Rail Guides

THE 20-in. back geared crank shaper, described and illustrated in this article, has been placed on the market recently by the Whipp Machine Tool Company, Sidney, Ohio. This machine is made in 16-in. and 20-in. sizes

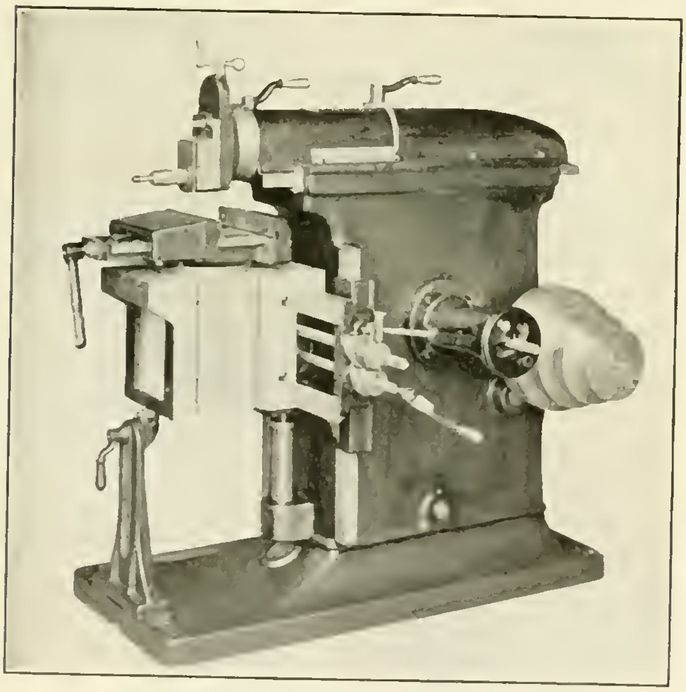


Fig. 1—Whipp 20-In. Crank Shaper

and a particular feature is the unusual width between the cross rail guides, more plainly indicated in Fig 2. The wide guides on the column form a pair of external ribs, which provide unusual column stiffness and rigidity. At the same time, a wide guide is provided for the cross rail itself, so that the work never overhangs the guides.

Particular attention is called to the arrangement for supporting the cone pulley shown in Fig. 1. In this design the

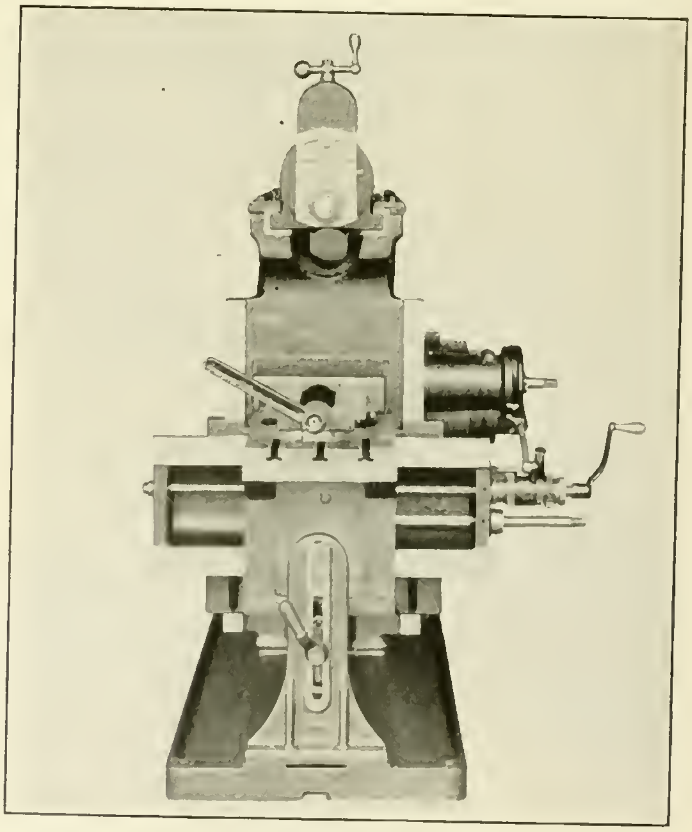


Fig. 2—Showing Unusual Width Between Cross Rail Guides

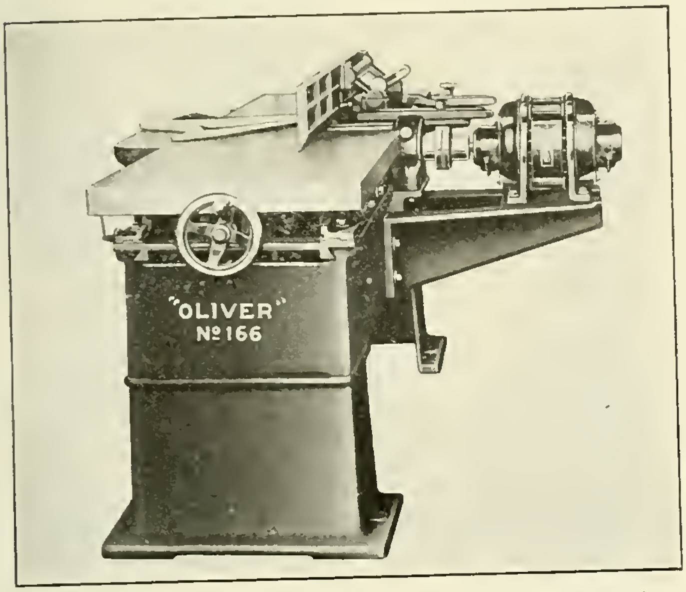
hub of the cone pulley is flush with the small end of the cone which allows the bearing in the column itself to extend nearly to the center of the cone. This assures a much stiffer

bearing than would be the case where an outboard support or sleeve bearing is used. Correct alinement of the pulley and shaft is maintained under heavy belt pull, a most important advantage.

An eccentric locking bolt is provided for locking the swivel plate to the head. This holds the head solidly to the ram and at the same time provides a quick and easy method for releasing when the head is to be swiveled.

The shaper base is arranged to prevent oil from dripping on the floor. Extension of the ram guides at both the front and rear of the column provides a long ram bearing and to secure accurate alinement, the elevating screw nut is carried in the main column casting. A table support may be furnished with the shaper and applied to the base extension as illustrated. This arrangement increases the rigidity of the table under heavy cuts.

New Driving Arrangement for Hand Planer



Hand Planer and Jointer Arranged for Direct Motor Drive

FOR some time hand planing and jointing machines placed on the market by the Oliver Machinery Company, Grand Rapids, Mich., were arranged with the motor built into the machine. This arrangement, however, did not permit of sufficient flexibility, inasmuch as the machine could be used only in a shop provided with the particular electric circuit for which its motor was designed.

In order to overcome this difficulty a new type of drive connection has been developed, which permits the use of any type of electric motor, provided its speed is approximately 3,600 r. p. m. In other words, the machine illustrated can be furnished with a motor to operate on direct current, or alternating current, with single, two, or three-phase voltage.

All belting is eliminated since the motor is directly connected to the revolving cutter head. The efficiency of the machine is increased on account of fewer bearings and no belting and the absence of belt guards saves considerable floor space. The machine is equipped regularly with three high speed knives in the head, which is of the Oliver round or safety type. On account of the high speed, the machine above described is capable of producing smooth work required in cabinet shops and pattern shops.

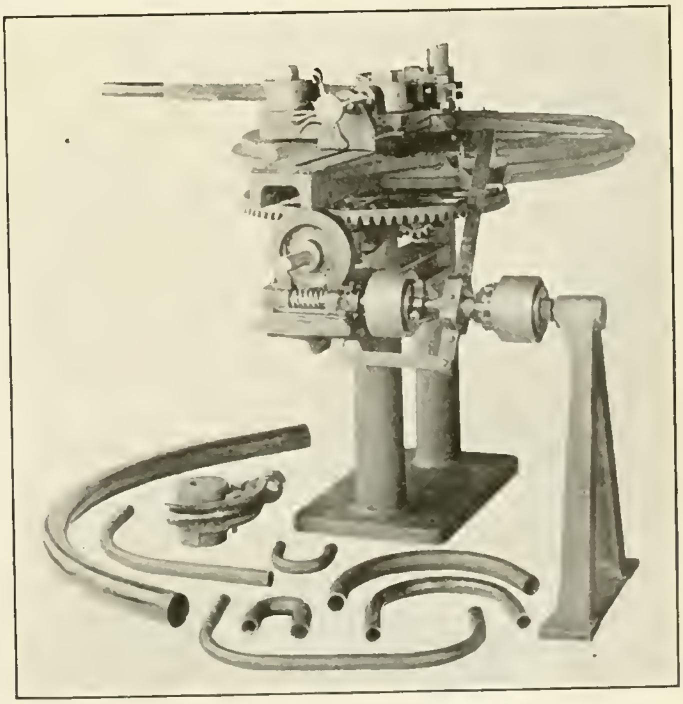
Pipe Bending Machine Is a Labor Saver

LOCOMOTIVE construction and repair work in particular, require a good deal of piping and in these days of high labor cost it is important that all shops be equipped with power-operated, pipe bending machines. The pipe bender, illustrated, is made by the Wallace Supplies Manufacturing Company, Chicago, and has a capacity to bend cold pipe up to two inches in diameter. Ordinarily no inside follower or floating mandrel is necessary, but these can be used when bending special forms.

The standard equipment furnished with the machine consists of four forming heads which may be used for bending one-inch iron pipe to an angle of 90 deg., with a six-inch radius; 1¼-in. pipe to an angle of 90 deg. with nine-inch radius; 1½-in., 90 deg. with 12-in. radius; 2-in., 90 deg., 14-in. radius. The pipe is secured to the form by means of a strap as indicated, and both the follower and the form are grooved with the proper clearance to secure the best results.

The outside follower bar operates between the tube and the roller instead of the roller working directly on the tube. This method supports the tube for a greater distance and obviates the depression which usually shows on the tube when the roller operates directly on the materials. The roller bracket is adjustable to take forms up to 50 in. in diameter and is operated on a screw to force the tube into the form and for holding the follower bar close to the tube. This is necessary in order to secure the best possible results.

The machine is operated by lever for forward and reverse friction clutch pulleys, with adjustable stops provided to suit any degree of bend required. The clutch is automatically thrown out of engagement at both the end of the bending operation and when the machine has been reversed to the starting position. Special forms with inside follower bars or floating mandrels can be furnished to order for bending light gage tubing to a short radius without flattening or crimping.



Wallace Pipe Bending Machine

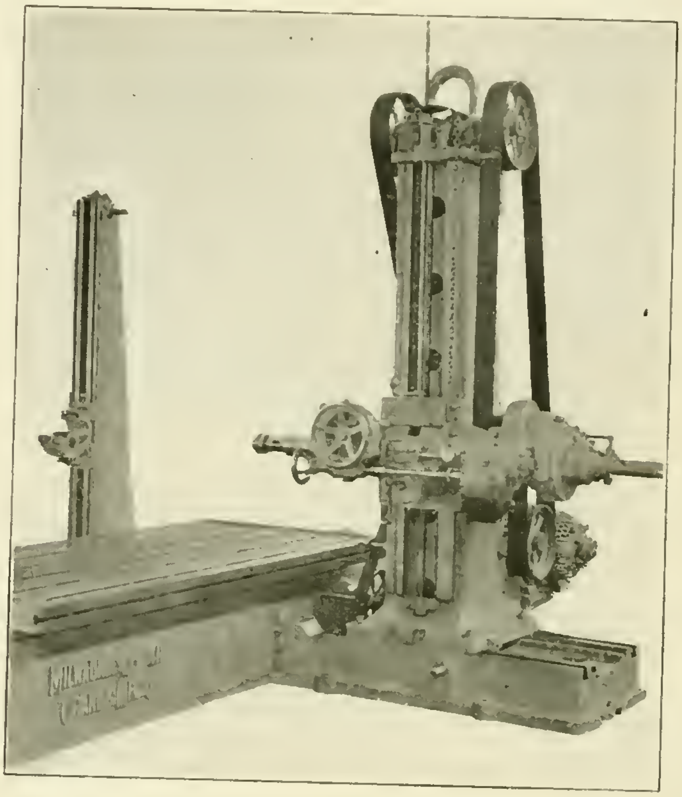
Horizontal Drilling and Boring Machine

A HORIZONTAL drill designed to cover a wide range of drilling and boring operations at one setting has been developed recently by the Malwaukee Electric Crane & Manufacturing Company, Milwaukee, Wis. By the use of this machine, it is possible to perform drilling operations on castings too bulky for the usual type of drill. Double setting of the work is avoided with a considerable saving of time, and the elimination of errors when boring holes for shafts or bearings, required to be parallel. Greater durability and accuracy in operation, as well as a more rapid change in speed and manipulation, has been secured by means of a direct-connected variable speed reversible motor. The arrangement illustrated provides high durability and efficiency and eliminates the use of gears in transmitting power from the motor to the spindle.

The spindle is of high carbon steel, accurately finished, the front end being fitted with a ball thrust bearing and a No. 5 Morse taper hole. Arrangement is made by means of a special cross key and nut for drawing up and releasing boring bars or tools. The spindle torque is not transmitted through the tang of the drill socket or boring bar when the work is heavy. The heavy rack teeth are arranged to automatically cut out the drive when the spindle reaches the extreme feed range. Danger of stripping the feed mechanism is thereby eliminated. The spindle is geared for standard speeds of 20 to 400 r.p.m. With a four to one motor speed range and 16-point controller, 32 different speeds are obtained with a single back gear ratio of five to one.

Six spindle feeds are provided for this drill from .009 in. to .070 in. per revolution. The feed is cut in or out by means of a trip lever and quick return or advance secured by the handwheel on the quill pinion shaft. The carriage elevating and lowering mechanism is operated by power or hand and the driving gear is provided with a limiting torque clutch as a safety feature. The hand adjustment is used only to secure final setting of the carriage. A steel scale on the face of the column indicates the distance from the top of the table to the center of the spindle.

The standard table furnished with the machine is 4 ft. wide by 9 ft. long and slides on a heavy planed cast iron bed. The table is power operated by a heavy screw capable of easy and accurate adjustment from both sides of the work. Suitable T-slots are provided for clamping the work or fixtures. All control levers are placed on the spindle carriage within convenient reach of the operator.



Milwaukee No. 25 Horizontal Drill Driven by 5-Hp. Motor

Small Pneumatic Hand Drilling Machine

FOR drilling staybolt telltale holes and other small holes, a drill developed by the Desoutter Brothers, Ltd., London, can be used to good advantage. The machine, shown in Fig. 1, is of novel design and takes the form of a cylinder 4 in. long by 1½ in. diameter, with the chuck protruding. It weighs only 1 lb. 14 oz. and takes drills up to ¼ in. The tool is grasped in the palm of the hand and the air supply is controlled by a press button in the head of the drill. The motor consists of a block of

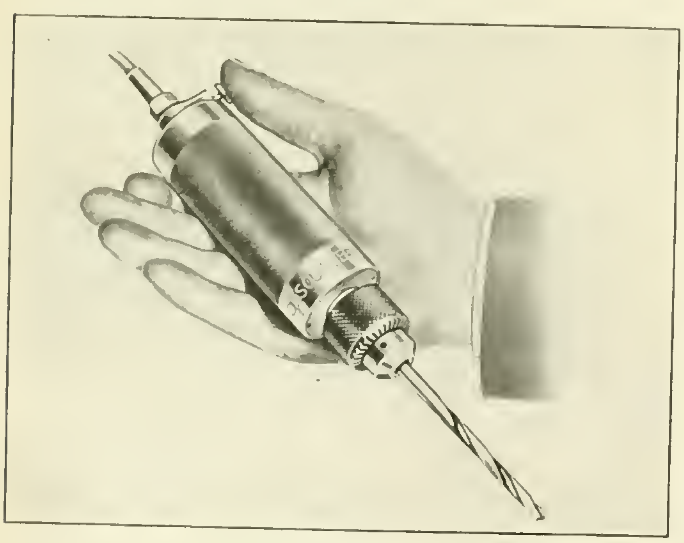


Fig. 1—Desoutter Pneumatic Hand Drill

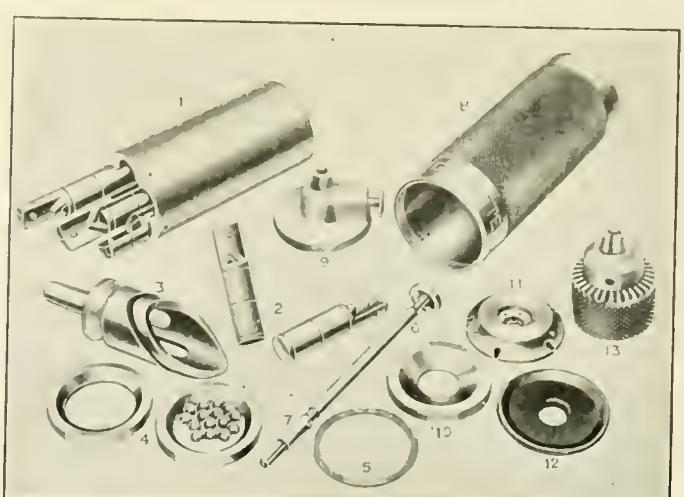


Fig. 2—Hand Drill Disassembled

five cylinders, of 7/16-in. bore and 1⅛-in. stroke, arranged symmetrically with respect to a control axis, with their bores *1*, Fig 2, parallel.

The piston for each cylinder is hollow and the working faces *2* are cut on the lower end to fit a specially shaped cam *3*. The cam is mounted so as to rotate about the central axis partly inside the recessed portion of the cylinder block, the pistons being operated in succession, controlled by a rotary type distribution valve *6*. This valve works on the circular valve face in the center of the cylinder head *11*. As each piston reaches the top and then the bottom of its stroke, the valve automatically admits air in the first case and permits the exhaust to take place when the bottom of the stroke is reached. This occurs with each cylinder in succession. There being five cylinders and pistons, a continuous motion is thus given to the cam. At the bottom of each stroke two small ports are exposed in each cylinder, which allow oil to be blown onto the cam face and ball race. The cylinder heads, valve face, inlet and exhaust ports are all in one piece, *11*.

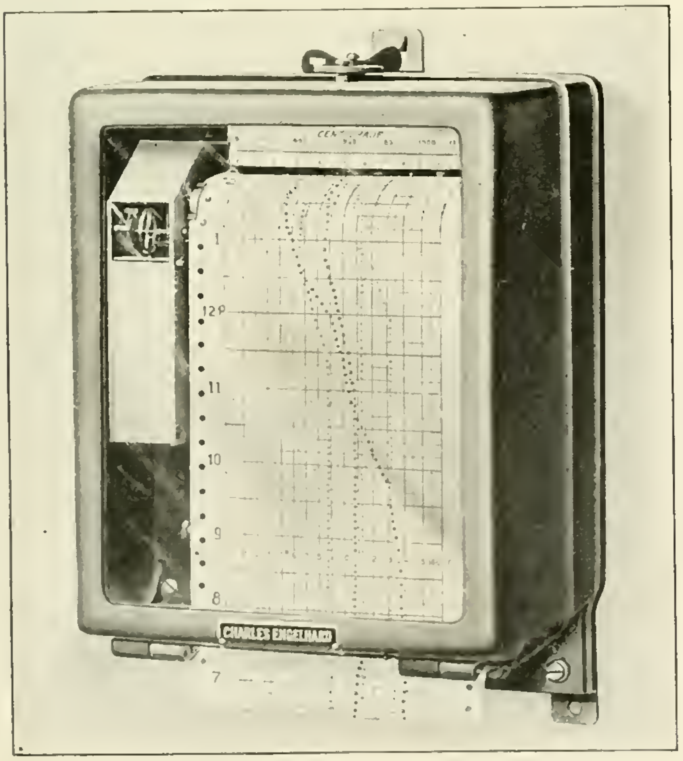
The cam rotates in a large ball bearing of which it forms the central member. Two large diameter outer races, fitted with balls of ample size, complete the essentials of the bearing. The thin steel ring, *5*, is a distance piece clamped between the outer races and forms the only adjustment required. The internals of the drill are kept in place by the screwed control valve housing *9* and the screw disk *10*. The chuck is kept on by a taper fit and screw.

An important factor in the efficiency of the drill, as far as air consumption is concerned, is the arrangement of employing one valve to control five cylinders, thereby reducing leakage to a minimum. Loss of air is also prevented by having the valve ports directly on top of each cylinder. Friction on the valve face is reduced to a small amount by a special balancing device. The form of construction of the cylinder block presents a means of getting the maximum power in the smallest space practicable.

The control valve is of the slide valve type, controlled by a push button. The rod of the press button acts as a piston, working through a small leather gland, the working pressure being used to force this outwards, thus automatically closing the control valve. The drill is well adapted for use in sheet metal shops and in fact any shop having many light hand drilling operations.

Pyrometer Recorder for Tool Room Use

Most modern railway tool rooms are, or should be, provided with heat treating equipment including pyrometers, but in many cases no arrangements are made for pyrometer recording instruments. Several installations already made of these instruments have proved their value as an effective check on the tool maker. More uniform and better results in the heat treating of tool steel have been secured.



Engelhard Pyrometer Recording Instrument

A recording instrument designed to record temperatures registered by pyrometers has been placed on the market recently by Charles Engelhard, New York. With the idea of making it as thoroughly fool proof as possible this instrument is divided into two compartments, in one of which the sensitive moving system, carefully protected against accident, is mounted. In the front compartment, the clock and depressor bar mechanism as well as a direct reading scale is mounted, as indicated in the illustration. This construction eliminates danger of breakage if inexperienced or careless men replace the charts.

The charts are of the continuous roll type, approximately 100 ft. long, which allows records of practically any desired time length to be kept. The time-temperature lines are at right angles to one another, thus forming rectangular coordinates and a strictly proportionate chart. The temperature lines run longitudinally on the chart and the time lines across. The clock is provided with double main springs furnishing ample power and the chart drum, which drives the chart at its specified rate, is geared to the clock by interchangeable gears. Records are formed by a series of dots, an interval between dots corresponding to one minute. Therefore, on a four record instrument, a record is made on each thermo-couple once every four minutes.

A color carrying roller is located near the front of the instrument, just in back of and below the scale. It runs straight across the instrument, the chart coming up in back and over the color roller. The pointer swings just above the chart. Above the pointer is the depressor bar with its straight edge directly above the center of the color roller. When a record is formed, the depressor bar is allowed to fall upon the pointer of the instrument. It causes a record of the position of the pointer to be made by pressing the pointer against the chart beneath and squeezing the chart paper between the pointer and the color roller underneath the chart. A small quantity of the pigment is taken up on the under side of the chart, which is transparent, allowing the color to show through clearly.

All contacts in the thermo-couple circuit are of silver with a heavy gold plate. The operation gives a wiping effect, insuring perfect operation of the contacts. Simplicity combined with careful design and construction of the pyrometer recorder insures accurate results and long life with reasonable care in handling.

Co-Operative Stores.—Information on how to start and conduct a co-operative store may be obtained from the Co-Operative League of America, 2 West Thirteenth street, New York.

Railway Mechanical Engineer

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WE GUARANTEE that of this issue 10,600 copies were printed; that of these 10,600 copies, 9,766 were mailed to regular paid subscribers, 13 were provided for counter and news company sales, 259 were mailed to advertisers, 32 were mailed to employees and correspondents, and 530 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 94,650, an average of 11,831 copies a month.

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It has been estimated that the value of the total output of machine tools in Great Britain during 1919 was about £10,000,000.

Employees in the machine and car shops on the Santa Fe system have agreed to work nine hours per day, instead of eight, beginning July 19, until the shortage of equipment is overcome.

The Chicago, Milwaukee & St. Paul car repair shops at Milwaukee, Wis., were destroyed by fire on July 18. The building was 600 ft. by 1,500 ft. and the estimated loss is $250,000. More than 100 freight cars were also destroyed.

A request of Cincinnati machine tool builders that Chinese students be admitted to this country to learn the machine tool trade has, it is understood, been refused by Louis F. Post, assistant secretary of the Department of Labor. The decision not to admit the Chinese was made by Mr. Post on a strict interpretation of the word "student."

The Speedograph locomotive recording chart shown on page 489 of the July *Railway Mechanical Engineer* was erroneously stated to cover a period of four hours, instead of two hours as is really the case. The recording tape is calibrated in minutes and there are 120 of the smallest divisions, making a total of 120 minutes or two hours.

While the Illinois Central had a number of cars of the compartment type like those found generally in Europe in the Chicago suburban service, it is learned that 50 new steel coaches now being built for that company's suburban service have end doors only. These cars are being so constructed as to be available for conversion to electrical operation when the company's electrification scheme is completed.

The board of directors of the Manila Railroad Company, which operates 647 miles of track in the Philippine Islands, nearly all on the island of Luzon, has authorized the expenditure of $2,500,000 for new equipment and betterments. The directors approved requisitions for 30 new locomotives, 100 thirty-ton freight cars and 25 additional passenger coaches. Bids for furnishing this equipment will be opened soon in New York.

The decennial celebration of the establishment of the United States Forest Products Laboratory at Madison, Wis., was held in that city on July 22 and 23, at which time an opportunity was offered to make a detailed inspection of the laboratory and of the work which it is doing. A program was also presented at which the work of the laboratory was reviewed and conferences held to promote the interests of forestry in this country.

Cable advices from Tokyo, under date of July 7, received in banking sources in New York say that a bill has been introduced by government in the Japanese Parliament creating the Imperial Electric Railway Company. The aim of the bill is to establish electrical power supply for railroads and to gradually convert steam railroads to electric. Capital will be 100,000,000 yen ($50,000,000), of which one-half will be invested by the government.

During the month of May 152 locomotives were exported, valued at $5,906,046. From the standpoint of value this represents the greatest export of locomotives for any month this year to date. The exports of freight cars in May totaled 1,884, valued at $3,789,237; passenger cars 14, valued at $110,798, and car parts $1,828,373. Car wheels and axles to the amount of $756,027 were exported during the month, compared with $593,394 in April.

At a meeting recently of representatives of all German railroad employees, with the exception of the Bavarians, it was decided to found a union of all employees. Already 350,000 members belong to this new organization. The resolution giving the board of directors the power to proclaim general strike in case of need is of special importance. Instead of sixty and more professional unions which are in existence now, the statutes of the new union allow for only nine professional organizations.

A home for boys who are taking courses in training in the apprentice department and live out of town has been started by the Brown & Sharpe Manufacturing Company, Providence, R. I. It is known as the Apprentice House and consists of a well-built three-story house located in a good residential section of Providence, a short distance from the works of the company and provides accommodation for 27 boys. It is the policy to maintain a thoroughly homelike atmosphere and to avoid any of the institutional tendencies often found in places of this kind. The house is provided with modern improvements in every way and is furnished with an aim toward comfort and a homelike environment.

The American Locomotive Company has perfected arrangements for teaching its alien employees the English language and for inducing such employees to become familiar with American ideals and to become citizens. Following the plans in effect in several other industrial plants, the classes in English for the men will take place afternoons, directly after working hours. Competent instructors will be placed in charge. The method of teaching will be similar to that employed in the General Electric Company, without using any foreign language and not using interpreters. Foundations for the language are laid in simple English phrases which the men encounter in their work every day. In one day seven men took the first steps toward citizenship.

The Western Electric Company has arranged with Columbia University, New York City, for post graduate courses for the technical men in its employ. The courses are limited to the members of the engineering department, where more than 3,000 technical men are eligible to take advantage of the offer. The hours of work in the engineering department have been especially arranged to provide those who attend the classes full opportunity for study. After the candidates are nominated by the officers of their department they must meet the academic qualifications of the University. A special course of training in technical work has also been started by the company, to instruct graduates of non-engineering colleges. The entire course takes nine months. Outside reading and lectures are required during that period.

A piston valve of the air pump of the Westinghouse brake on an English engine broke recently, says the Engineer, London. The locomotive was coupled to a passenger train, and when the fracture was discovered the driver had four miles to run, one stop to make, and the important junctions approaching the central station to be run through, and the stop in the station to be made. Besides the one stop the train had to be checked thrice and each of these occasions reduced the pressure. The train would probably have arrived safely, but at the last moment the driver thought he would not stop in time. He therefore reversed his engine, but this caused the engine wheels to lock and the train consequently ran into the buffers. Thanks to the hydraulic buffers, there was no material damage and little personal injury.

Winners in the Prize Story Contest

As the judges in the prize story contest felt that the relative merits of the stories could not be judged with fairness until after all had been published, their decision was reserved until this time. The last story was published in the July issue. Each of the judges has rated all the stories submitted.

The first prize of $75 has been awarded to Hugh K. Christie, whose story, Fools Rush in Where Angels Fear to Tread, appeared in the February issue. The second prize of $50 was won by E. F. Jones, author of the story in the June issue, How the Master Mechanic Increased Production. Andrew J. Fenton received the third prize of $25 for his story, How Jim Dugan Finally Won a "Real" Job, published in the January issue.

Co-Operative Course in Electrical Engineering

For the past year an interesting experiment in co-operative engineering education has been conducted by the Massachusetts Institute of Technology and the General Electric Company and several departures from the usual plan which were introduced have shown decided results. The class was limited to 30 students, who were chosen entirely on the records which they had made in the equivalent of the first two years' work of the electrical engineering course at Technology. The year is divided into four three-month periods, the students spending alternately 13 weeks at the Lynn works of the General Electric Company and 11 weeks at the Institute, followed by a two weeks' vacation. The group at Lynn is housed together in a residence which has been converted into a modern club house. No break is made in the major studies when the students are at Lynn, courses being conducted at the works in principles of electrical engineering and in general studies. The progress of the students through the plant is regulated, not by the production needs of the various departments, but by the advantage which the experience in each department is to the student. As evidence of its approval of the work, the company has increased the number of men who can be enrolled in this year's class to 60 and has already secured a new club house in order to furnish rooming accommodations for them.

MEETINGS AND CONVENTIONS

Chief Interchange Car Inspectors' and Car Foremen's Association.—The annual convention of this association will be held at the Windsor Hotel, Montreal, Que., September 14 to 16, inclusive.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Association, Section VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. B. Baker, Terminal Railroad, St. Louis, Mo.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention September 1-3, Hotel Sherman, Chicago.

American Society for Testing Materials.— C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meetings second Tuesday in month, except June, July and August.

Car Foremen's Association of Chicago.—Aaron Kline, 626 North Pine Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Friday in January, March, May and September and second Thursday in November, Hotel Statler, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill. Convention, September 14-16, Windsor Hotel, Montreal, Que.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, B. & O., Lima, O. Convention August 17-19, Hotel Statler, Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention Sept. 7-10, 1920, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B & M., Reading, Mass. Convention September 14-16, New American House, Boston, Mass.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meetings second Tuesday in month, except June, July, August and September.

New York Railroan Club.—H. D. Vought, 95 Liberty St., New York. Meetings third Friday in month, except June, July and August, 29 W. 39th St., New York.

Niagara Frontier Car Mens' Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y. Convention September 14, Chicago.

Western Railway Club.—J. M. Byrne, 916 West 78th St., Chicago. Meetings third Monday in month, except June, July and August.

PERSONAL MENTION

GENERAL

Norman W. Rose has been appointed electrical engineer of the Duluth & Iron Range, succeeding A. M. Frazee.

Robert McGraw has been appointed fuel instructor on the New York Central, with headquarters at Syracuse, N. Y.

Elmer R. Larson, supervisor of apprentices on the Delaware, Lackawanna & Western, has been appointed special motive power inspector.

A. T. Pfeiffer has been appointed assistant superintendent of fuel and locomotive performance on the New York Central, with headquarters at New York.

J. C. Brennan has been appointed supervisor of fuel and locomotive performance for the first district of the New York Central, with headquarters at Utica, N. Y.

E. C. Anderson, acting mechanical engineer of the Chicago, Burlington & Quincy, with headquarters at Chicago, has been appointed mechanical engineer, succeeding C. B. Young.

A. B. Corbett, division master mechanic of the Missouri, Kansas & Texas of Texas, at Denison, has been transferred in the same capacity to Greenville, Tex., succeeding H. Honaker.

C. W. Wheeler has been appointed supervisor of fuel and locomotive performance for the second district of the New York Central, with headquarters at Syracuse, N. Y., succeeding L. F. Burns.

A. J. Fries, assistant superintendent motive power of the second district, New York Central, with headquarters at Depew, N. Y., has had his title changed to district superintendent of motive power.

J. F. Hill, master mechanic of the Wheeling & Lake Erie at Brewster, Ohio, has been promoted to superintendent of motive power and cars with the same headquarters, succeeding George Durham, resigned.

R. J. Needham, mechanical and electrical engineer on the Grand Trunk, has been appointed assistant to the general superintendent of the motive power and car departments, with headquarters at Montreal, Que.

L. F. Burns, district supervisor of fuel economy of the New York Central at Rochester, N. Y., has been appointed master mechanic of the Syracuse division, with headquarters at East Buffalo, succeeding M. W. Hassett.

W. P. Davis, master mechanic of the Harlem division of the New York Central, with headquarters at Brewster, N. Y., has been transferred to the Mohawk division, with headquarters at West Albany, succeeding C. F. Parsons.

H. Wanamaker, superintendent of shops of the New York Central at West Albany, N. Y., has been appointed district superintendent of motive power of the first district, succeeding C. H. Hogan, with headquarters at Albany.

C. H. Hogan, district superintendent of motive power, first district, of the New York Central, with headquarters at Albany, N. Y., has been promoted to manager of the department of shop labor, with headquarters at Buffalo, N. Y.

F. S. Gallagher, assistant engineer in the general mechanical engineer's office of the New York Central, has been appointed engineer of rolling stock with office in New York, under B. B. Milner, engineer of rolling stock and motive power. Mr. Gallagher was born at Tecumseh, Mich., and began railroad work as a machinist apprentice. He was later employed by the Pullman Company and the Lake Shore & Michigan Southern as a draftsman, leaving the latter road to come with the New York Central as assistant engineer in the general mechanical engineer's office.

J. W. Chandler, district foreman on the Poteau Valley line of the Kansas City Southern, with headquarters at Heavener, Okla., has been promoted to master mechanic, with headquarters at Shreveport, La., succeeding A. D. Williams.

R. W. Anderson, assistant superintendent motive power of the Chicago, Milwaukee & St. Paul, Lines East, with headquarters at Milwaukee, Wis., has been appointed superintendent motive power with the same headquarters. Mr. Anderson was born on May 6, 1877, in Madison county, Iowa. He began railroad work in January, 1892, as a machinist apprentice for the Des Moines Union. In January, 1897, he went to the Chicago, Rock Island & Pacific as machinist and retained that position until May, 1903, when he was promoted to assistant roundhouse foreman. Some months later he became roundhouse foreman. He entered the employ of the Chicago, Milwaukee & St. Paul as machinist at Mitchell, S. D., in September, 1904, and in November, 1905, was appointed assistant roundhouse foreman at the same place. He was transferred as machinist to the Idaho division in September, 1907, and in June of the following year was promoted to mechanical foreman of the same division. From May, 1908, until August, 1911, he served as roundhouse foreman at Avery, Idaho. He was then transferred to Miles City, Mont., and while there was appointed district master mechanic in November, 1912. He retained that position until June, 1918, when he was promoted to assistant superintendent motive power, as mentioned above.

R. W. Anderson

C. B. Young, who was recently reappointed mechanical engineer of the Chicago, Burlington & Quincy, with headquarters at Chicago, as noted in these columns last month, has been promoted to general mechanical engineer, with the same headquarters.

L. K. Sillcox, recently appointed assistant general superintendent motive power of the Chicago, Milwaukee & St. Paul, has now been appointed general superintendent motive power, with headquarters at Milwaukee, Wis., succeeding H. R. Warnock.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. H. Henley, master mechanic of the Missouri, Kansas & Texas at Parsons, Kan., has been appointed road foreman of engines and will have his headquarters at Muskogee, Okla.

C. F. Parsons, master mechanic of the New York Central at West Albany, N. Y., has been appointed general master mechanic of the first district, with headquarters at Albany.

A. D. Williams has been appointed master mechanic of the Texarkana & Fort Smith, with headquarters at Texarkana, Tex., succeeding F. M. Hill assigned to other duties.

M. W. Hassett, master mechanic of the New York Central at East Buffalo, N. Y., has been appointed general master mechanic of the second district, with the same headquarters.

W. H. Eckroate, road foreman of engines of the Wheeling & Lake Erie at Brewster, Ohio, has been appointed master mechanic, succeeding J. F. Hill, with the same headquarters.

J. J. Melley, master mechanic of the Missouri, Kansas & Texas, of Texas, at Wichita Falls, Tex., has been transferred to Parsons, Kan., succeeding J. H. Henley as master mechanic there.

A. J. Lewis, shop superintendent of the Missouri, Kansas & Texas of Texas, at Denison, has been appointed division master mechanic, with the same headquarters, succeeding A. B. Corbett.

H. Honaker, master mechanic of the Missouri, Kansas & Texas of Texas, with headquarters at Greenville, Tex., has been transferred in the same capacity to Wichita Falls, Tex., succeeding J. J. Melley.

A. T. Heintz, assistant master mechanic of the Mohawk division of the New York Central at West Albany, N. Y. has been appointed master mechanic of the Harlem division, with headquarters at Brewster, N. Y., succeeding W. P. Davis.

CAR DEPARTMENT

J. H. Douglas, general shop foreman of the Wheeling & Lake Erie at Ironville, Ohio, has been promoted to master car builder, with headquarters at Brewster, Ohio.

A. J. Williams, assistant road foreman of engines on the Maryland division of the Pennsylvania, has been appointed general air brake and steam heat inspector on the Southern division.

Charles I. Walker, whose promotion to master car repairer of the Southern Pacific, with headquarters at Los Angeles, Cal., was announced in these columns last month, was born on December 3, 1875, at Hillsboro, Mo. Mr. Walker entered railway service as an apprentice car builder with the St. Louis, Iron Mountain & Southern on July 27, 1891, and during the next seven years served in several branches of this department. In June, 1898, he entered the service of the Mexican National, with headquarters at Laredo, Tex., as a car builder. In September, 1898, he went with the St. Charles Car Company at St. Charles, Mo. and in August, 1900, with the Pullman Company at Chicago, where he was later promoted to assistant foreman. In July, 1904, he returned to the Mexican National at Laredo, and on February 1, 1905, he was promoted to master car builder on that system. He was appointed foreman in the passenger repair department of the Cincinnati, Hamilton & Dayton, with headquarters at Lima, O., in July, 1906. In October 1907, he became a shop foreman on the Southern Pacific, and shortly thereafter was appointed draftsman. After a short service as inspector, he was transferred, in May, 1919, to the general freight car department at San Francisco, Cal., where he was located at the time of his recent promotion.

SHOP AND ENGINEHOUSE

D. Johnson has been appointed general foreman of the Erie at Marion, Ohio, succeeding R. M. Wilson, transferred.

H. Schmidt has been appointed roundhouse foreman of the Erie at Cleveland, Ohio, succeeding F. C. Hunter, transferred.

J. B. Fraser has been appointed shop foreman of the Canadian National at Saskatoon, Sask., succeeding A. D. McMillan, resigned.

B. C. Nicholson has been appointed shop superintendent at Denison, Tex., of the Missouri, Kansas & Texas of Texas, succeeding A. J. Lewis.

S. J. Dillon, enginehouse foreman of the Pennsylvania at Atlantic City, N. J., has been appointed shop inspector on the New Jersey division.

Enoch Hewitt, general foreman of the Pennsylvania shops at Meadows, N. J., has been appointed enginehouse foreman at Atlantic City, succeeding S. J. Dillon.

John Murray, assistant supervisor of apprentices on the Delaware, Lackawanna & Western, has been promoted to supervisor of apprentices, succeeding Elmer R. Larson.

J. G. Parsons, superintendent of shops of the New York Central at Depew, N. Y., has been transferred to West Albany as superintendent of shops, succeeding H. Wanamaker.

J. C. LaPort, enginehouse foreman of the Pennsylvania at Coalport, has been appointed general foreman of the Meadows shops, Meadows, N. J., succeeding Enoch Hewitt.

B. F. Shone, general foreman of the locomotive department of the New York Central at Depew, N. Y., has been appointed superintendent of shops there, succeeding J. G. Parsons.

PURCHASING AND STOREKEEPING

Daniel W. Roberts, division storekeeper of the Union Pacific at Kansas City, Mo., has been appointed general storekeeper of the Pere Marquette, with headquarters at Detroit, Mich. Mr. Roberts was in the service of the Union Pacific continuously since 1906, having entered the employ of that road as a call boy at Cheyenne, Wyo. In 1909 he was appointed storekeeper at Cheyenne, being transferred to Omaha, Neb., in 1911 and to North Platte, Neb., in 1913. In 1915 he returned to Cheyenne as division storekeeper and in 1917 went to Denver, Colo., in the same capacity. He was transferred to Kansas City in 1918, and held the position of division storekeeper there until he recently resigned it to accept his present one as general storekeeper of the Pere Marquette.

D. W. Roberts

E. H. Hughes has been appointed general storekeeper of the Kansas City Southern, with headquarters at Pittsburgh, Kans., succeeding R. C. Lowry, resigned.

OBITUARY

Benjamin F. Sarver, boilermaker foreman of the Pennsylvania at Fort Wayne, Ind., died of heart disease on July 23 at a hospital in Chicago. Mr. Sarver was a member of the executive board of the Master Boiler Makers' Association and was one of its earliest members.

SUPPLY TRADE NOTES

James L. Gough, president of the Federal Machinery Sales Company, Chicago, has retired from active business.

Frank J. Farrell has been appointed eastern representative of the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa.

Clark T. Dickerman, sales agent for the American Car & Foundry Company, with headquarters at New York, has been transferred to the Chicago office.

B. M. Jones & Co., Inc., New York, distributors for Double Mushet high speed steel and Taylor's Best Yorkshire iron, announce that they are now being represented in the southeastern territory by the W. S. Murrian Company, 605 Fourth street, Knoxville, Tenn. W. S. Murrian for a number of years was connected with the mechanical department of the Southern Railway, but during the war period he was associated with the United States Railroad Administration, Railway Board of Adjustment No. 2. His son, John H. Murrian, has recently been discharged from the army, having served with the American Overseas Air Force and being the possessor of three distinguished foreign decorations.

W. S. Murrian

G. M. Calmback, welding supervisor of the Kansas City Southern, has been appointed welding advisory engineer of the Geist Manufacturing Company, Atlantic City, N. J.

Roland Whitehurst, of the New York sales office of the Electric Storage Battery Company, Philadelphia, Pa., has been appointed manager of the Washington, D. C., sales office.

T. W. McManus, master mechanic for the Kellogg Switchboard & Supply Company, Chicago, has been elected vice-president and general manager of the Security Tool Works, Chicago.

W. W. Rosser, vice-president of the T. H. Symington Company, Rochester, N. Y., has become associated with the Bradford Draft Gear Company, New York, with headquarters at Chicago.

W. L. Randall and T. D. Randall of D. W. Randall & Co., Chicago, have recently organized the Randall Foundry and will build a plant at Michigan City, Ind., for the manufacture of grey iron castings for railway equipment.

The Halcomb Steel Company, Syracuse, N. Y., announces the opening of a branch office and warehouse with a complete stock of the company's tool steel products. The New York office will be under the management of F. W. Ross.

The Electric Controller & Manufacturing Company, Cleveland, Ohio, has opened a new office in Philadelphia, in charge of H. K. Hardcastle. It is located in the Witherspoon building, at the corner of Walnut and Juniper streets.

W. S. Quigley, president of the Quigley Furnace Specialties Company, New York, recently sailed for Europe for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

The Refinite Company, Omaha, Neb., manufacturer of the Refinite water softener and the Refinite rapid pressure filter, has just acquired ownership and control of the L. M. Booth Company, Jersey City, N. J., manufacturer of the Booth limesoda water softener.

The Air Reduction Sales Company has just completed the construction of a new acetylene plant at 560 Broadway, Gloucester, N. J. The buildings making up this new unit consist of a gas house, carbide storage building and a generator house.

The American Car & Foundry Company has recently purchased two additional pieces of real estate for its contemplated $2,000,000 plant extending from Blue Island avenue, along Paulina street to the Chicago river, at Chicago. The land, now occupied by the company, was formerly under lease.

The general offices of the Wilson Welder & Metals Company, formerly at 2 Rector street, New York, have been moved to 253 Thirty-sixth street, Bush Terminal, Brooklyn, N. Y. The offices of the Wilson Welding Repair Company, formerly of the same address, are now at 263 First street, Jersey City, N. J.

Simon M. Dolan has been elected vice-president of the G. F. Cotter Supply Company, Houston, Tex. He began railway work with the Baltimore & Ohio as a boilermaker apprentice at Garrett, Ind. Two years later he was made a machinist apprentice, and subsequently served on various railroads and in industries as a machinist and for a short time as a locomotive fireman. From 1894 to 1902, he was with the Wiggins Ferry Company, St. Louis, consecutively as general foreman, master mechanic and superintendent, and also served as master mechanic on other railroads. He subsequently went to the Southern Railway as general mechanical inspector, and later was master mechanic. In 1905 he went to the Missouri Pacific as a master mechanic at Little Rock, Ark., and later served in the shops at Sedalia, Mo. In 1908 he entered the service of the Scullin Steel Company in its steel plant and later was sales agent and assistant to the vice-president in charge of sales, respectively. He was sales agent for the American Car & Foundry Company, St. Louis, in 1911, and four years later went with the Chicago Varnish Company, resigning recently from the position of western and southwestern representative of its railroad department to become vice-president of the G. F. Cotter Supply Company.

S. M. Dolan

Alfred Herbert, Ltd., machine tool makers and importers, Coventry, England, announce that E. D. Mitchell, for many years a member of the Coventry staff, and lately assistant manager of the New York branch, has been appointed man-

ager at New York, to succeed W. J. Fuller, who has resigned from that position.

B. B. Milner, now engineer of motive power and rolling stock of New York Central, has completed arrangements for becoming associated with the Oriental organization of Frazar & Co., 30 Church street, New York, and will sail for his new headquarters in the Tokio, Japan, offices of Sale & Frazar, Ltd., some time this fall.

The New York Air Brake Company, New York, has opened an office in room 1405, Walker Bank building, Salt Lake City, Utah, which will be the headquarters for Captain Thomas O'Leary, Jr., representative. Captain O'Leary has acted as representative of the company in western territory since his return from France.

F. V. Green, who left the service of the Westinghouse Air Brake Company some time ago to become associated with the Baldwin Locomotive Works, has now opened his office in the Standard Bank building, Johannesburg, South Africa. Mr. Green is export manager for the Baldwin Locomotive Works, in charge of South African territory.

Albert G. Elvin, who has been elected vice-president in charge of operation and treasurer of the Elvin Mechanical Stoker Company, New York, as was announced in the July issue, was born on February 26, 1865, at North Vernon, Ind., and was educated in the public schools. He began railway work in 1881, serving as boiler-maker and machinist apprentice at Peru, Ind., on the Indianapolis, Peru & Chicago. In 1889 he went to the Pittsburgh, Cincinnati, Chicago & St. Louis at Indianapolis as a machinist and in 1890, was put in charge of the tool shop, manufacturing all tools for the entire system. He was later general foreman on the Chesapeake & Ohio at Clifton Forge, Va., master mechanic on the Grand Trunk, Montreal, Que., and in January, 1901, he was appointed general master mechanic on the Delaware, Lackawanna & Western at Scranton, Pa. During this time he designed and put into operation many labor-saving devices. Among these, in 1896, he introduced the first pneumatically operated turntables and transfer tables in this country. In 1902 he invented and patented the Elvin driving box lubricator, which is known today as the Franklin driving box lubricator and has been standard on the majority of locomotives in the United States and Canada for the past 14 years. In 1903 he went to the Franklin Railway Supply Company, then known as the Coffin-Megeath Supply Company, and remained with the company as mechanical manager until 1916, when he retired from active work due to a breakdown in health. During the time he was associated with the Franklin Railway Supply Company he invented and patented a pneumatic firedoor, and the steam grate shaker. The latest of his devices is the Elvin mechanical stoker, which has been in successful service for the past three years on the Erie Railroad.

A. G. Elvin

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, announces that the Minnesota Supply Company, 802 Pioneer building, St. Paul, Minn., has been appointed its northwest sales representative. The business is in charge of W. H. Hooper, who has been engaged in railway work and the railway supply field for the past 25 years.

The extensive improvements contemplated by the Pollak Steel Company, Cincinnati, Ohio, for its rolling mill at Marion, Ohio, some time ago, are now in the course of actual construction. The improvements consist of several new buildings, equipment, etc. The products of this plant consist of rolled steel bars and shapes, concrete reinforcing bars, etc.

The Clark-Mesker Company, Cleveland, Ohio, was recently incorporated for the purpose of taking over the machine tool department of the Cleveland Milling Machine Company. The officers of the new company are as follows: D. B. Clark, president; L. H. Mesker, vice-president and general manager, and Charles A. Morris, secretary and treasurer.

The Imperial Japanese government has conferred the Fourth Class of the Imperial Order of Mediji upon Charles M. Muchnic, vice-president of the American Locomotive Sales Corporation, New York, and invested him with the insignia of the Imperial Order of the Rising Sun pertaining to said class, in expression of the good will which it entertains towards him.

R. T. Hazelton has been appointed works manager, in complete charge of production, of the Cincinnati Shaper Company, Cincinnati, Ohio, and will also act in this capacity for the Cincinnati Gear Cutting Machine Company, a subsidiary of the Cincinnati Shaper Company. Mr. Hazelton was formerly superintendent and chief engineer of the Cincinnati Milling Machine Company.

The Burden Iron Company, Troy, N. Y., has entered into a contract for a term of years with the Burden Iron Company Railroad and Steamship Division, to dispose of its products as applied to railroad and steamship companies. Edward L. Smith is the general partner of this newly organized partnership, and W. J. Caton has been appointed secretary, with office at 3711 Grand Central Terminal, New York.

The Worthington Pump & Machinery Corporation, New York, announces the purchase from the Platt Iron Works, Dayton, Ohio, of its drawings, patterns, jigs, templates, special tools, good-will and name, on its following lines of product: Oil mill machinery, hydraulic turbines and water wheels, feed water heaters and high pressure air compressors for torpedo and other high pressure charging, cleaning and discharging.

T. D. Slingman has joined the sales organization of the Keller Pneumatic Tool Company, Grand Haven, Mich., as special representative, with headquarters at its Pittsburgh office. Mr. Slingman has for many years been identified with the selling organization of the Chicago Pneumatic Tool Company, for the past nine years as district manager at Detroit. He left the service of that company on June 1 and shortly thereafter joined the Keller force.

The drop forging business and plants of the Whitman & Barnes Manufacturing Company at Chicago and St. Catharines, Ont., have been combined with the J. H. Williams & Co., Brooklyn, and will be operated by this company. The organization will include the individuals heretofore identified with both businesses. The business of the Whitman & Barnes Manufacturing Company, Akron, Ohio, will be confined to the manufacture of twist drills and reamers.

Edward A. Schreiber, general manager of the Vapor Car Heating Company, Railway Exchange building, Chicago, died on July 4 from heart trouble, following a previous at-

tack on May 20, just after his return from a European trip in the interest of the car heating company. Mr. Schreiber was formerly connected with the steam fitting department at the Pullman car works, and in 1901, entered the service of the Chicago Car Heating Company, predecessor of the present Vapor Car Heating Company, since which time, and up to his death at the age of 58, he was active in the affairs of that company.

L. E. Summers has been appointed works manager of the Keller Pneumatic Tool Company's factory at Grand Haven, Mich. Mr. Summers is one of the pioneers in the mechanical department of the pneumatic tool industry, having started his career in 1894 with Joseph Boyer, St. Louis. He then went to the Boyer plant of the Chicago Pneumatic Tool Company, at Detroit, where he was assistant manager for nine years, and then he was works manager for eight years. He resigned in 1918, since which time he has been employed by various interests on the Pacific Coast, until he joined the Keller organization on June 1 of this year.

The Milwaukee Electric Railway & Light Company, after more than two years of continued use of pulverized coal under five boilers in the Oneida street plant, has decided to use this form of fuel in the new Lakeside power plant. The installation will consist of eight 1,306-hp. Edgemoor water tube boilers. The contract for the drying, pulverizing and transportation equipment has been placed with the Fuller Engineering Company, Allentown, Pa. The feeders and burners will be furnished by the Locomotive Pulverized Fuel Company, New York. Lopulco duplex feeders with five-inch screws will be used and three Lopulco burners will be installed in each boiler. The feeders will be driven by Morse silent chain and the Reeves type variable speed mechanism.

Charles P. King, formerly manager of the New York office of the Lima Locomotive Works, Inc., and who for several years previously traveled in the West Indies and Central and South American countries for the same corporation, on July 15 assumed charge of the car business of the Ralston Steel Car Company, Columbus, Ohio, as eastern sales and export representative at the offices of the Ralston Car Sales Corporation, the selling agent for the Ralston Steel Car Company, 2 Rector street, New York. Mr. King received his preliminary training in the car building business in the shops and offices of the old Jackson & Sharp Car Company, Wilmington, Del., under the direction of his father, A. M. King, who was, for many years, until his death in 1897, general superintendent of that company. Mr. King returns to the railroad field after a brief venture in the export trade-paper publishing business.

Harry R. Warnock, general superintendent of motive power of the Chicago, Milwaukee & St. Paul, has become associated with the Standard Stoker Company, New York, as vice-president in charge of the mechanical department, with headquarters at New York. Mr. Warnock was born at Newcastle, Pa., on July 16, 1870. He began railway work as a freight brakeman with the Pennsylvania Lines West of Pittsburgh in June, 1889. He later worked as a brakeman, locomotive fireman and engineman on the Pittsburgh & Lake Erie until May, 1900. From that date until July, 1904, he served consecutively as engine dispatcher, roundhouse foreman, and general foreman, resigning from that position to become master mechanic of the West Side Belt, Pittsburgh, Pa., where he remained until October, 1905, when he became master mechanic of the Monongahela Railroad. He remained in this position until September, 1913, when he was appointed superintendent of motive power of the Western Maryland, and on December 15, 1917, was appointed general superintendent of motive power of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago.

TRADE PUBLICATIONS

Oil Separator.—The Griscom-Russell Company, New York, describes the construction of the Bundy oil separator in a 12-page bulletin, No. 1130. This separator is designed for the removal of oil from exhaust steam in power plants. Sectional views and drawings make the construction and operation clear and instructions are given for cleaning.

Twist Drills and Reamers.—The Whitman & Barnes Manufacturing Company, Akron, Ohio, which is now manufacturing twist drills and reamers exclusively, has revised its catalogue to cover only these products. It contains 120 pages, giving prices and all necessary data. In the back of the book are tables of tap drill sizes, decimal equivalents of regular sizes, cutting feeds and speeds, etc.

Pneumatic Tools and Electric Drills.—The Independent Pneumatic Tool Company, Chicago, has revised its catalogue of Thor tools. The new book contains 78 pages, giving descriptions, illustrations, dimensions and sizes, and covers the new additions to the line, consisting of motor driven air hoists, pneumatic sand rammers, universal vise for pneumatic drills, hose coupling, power screw driver, hose clamp and hose mender.

Feedwater Heating.—Figures showing the amounts that may be saved on coal bills by preheating feedwater with the heater developed by the Locomotive Feed Water Heater Company, New York, are contained in bulletin No. 6, issued by that company. The savings are also presented graphically on a chart which is arranged to show the monthly saving per locomotive for any combination of fuel consumption and gross ton miles per month and for varying coal costs.

Automatic Train Line Connectors.—The Robinson Connector Company, New York, has recently issued a 23 page booklet illustrating the advantages and method of operation of the Robinson connector. Attention is called to the simplicity of the connector and its automatic features. Clear cut illustrations show how the connector is applied to the draw bar and a view is shown of the shop in which connector parts are made. The booklet is well illustrated and carefully written.

Driving Box Wedge.—The operation and construction of the Franklin automatic adjustable driving box wedge, which is claimed to maintain wedge adjustment under all conditions and increase the life of crown bearings and rod bushings, is described fully in a four-page pamphlet, bulletin No. 601, distributed by the Franklin Railway Supply Company, New York. Instructions are also given for applying the wedge on new and existing power and a drawing is included showing its proportions and the space that should be provided for wedges when designing new engines.

Die Heads.—The Eastern Machine Screw Corporation, New Haven, Conn., has compiled a 96-page catalogue covering H & G automatic self-opening die heads and collapsible taps, and in addition includes much valuable data relating to thread cutting that should be useful to men working out threading problems. The descriptions are concise and are well illustrated. They cover four types of die heads, a new H & G collapsible tap and chasers for the die heads. Detailed instructions for opening the heads, installing chasers, closing the heads and adjusting the pitch diameter, with information on cutting speeds and lubricants, is also included.

Railway Mechanical Engineer

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Advance In Subscription Rates

To Our Readers:

The subscription rate to the *Railway Mechanical Engineer* on the basis of the number of editorial pages is the same today as it was a quarter of a century or more ago; this with the exception of an increase which was recently made to readers west of the Mississippi river, caused by the establishment of the excessive zone postal charges. Hereafter the subscription rate throughout the United States, Canada and Mexico will be $4. The rate to subscribers in other countries will be $5, and the price of a single copy will be 50 cents.

The publishing business, like the railroad and all other businesses, has been subjected to large increases in its costs of production. There are, however, special influences affecting the publishing business about which we feel our readers should be told. The white paper used by newspapers and periodicals, for instance, constitutes one of the largest items in their cost of production. During the first six months of the year 1920 the expenditures for paper for the *Railway Mechanical Engineer* and the other railway papers published by the Simmons-Boardman Publishing Company were *191 per cent* greater than in the first six months of 1919. This increase in cost was due only in a small degree to an increase in the amount of paper used. It was caused largely by advances in the prices that we have had to pay.

Even if the advance in the price of paper was the only advance in cost that we had to meet, it would be serious; but it by no means stands alone. During the first six months of 1920 the expense of typesetting, press work, binding and bulk postage of our railway papers was 125 per cent greater than in 1919. During the same period the increase in the cost of the engravings used as illustrations in our editorial pages was 265 per cent.

These statistics indicate the increases which have occurred in our "manufacturing costs." We have also been affected by the same influences which have compelled business concerns of all kinds to increase the wages and salaries of their employees. Publications of all kinds, owing to similar developments have been forced to advance their subscription rates. Metropolitan newspapers which formerly sold for one cent are now being sold for two and even three cents.

We are deeply appreciative of the loyal support which we have always received from our readers. It will be our endeavor in the future, as it has been in the past, constantly to make the *Railway Mechanical Engineer* a better paper, and we bespeak your continued cordial co-operation.

Roy V. Wright,
Editor.

The All-Round Railroad Man

It was once remarked by an able railroad executive that the successful railroad man was one who knew something about every branch of railroading and everything about one department. This is unquestionably true and the fact is doubtless appreciated by many young men in railroad service. Is it not probable, however, that some of these young men are laboring under the impression that a general knowledge of each department is of the first importance and that the obvious

way in which to acquire an all-around knowledge of railway operation is to seek employment in various branches of the service by switching from one department to another as often as the opportunity presents itself? What the diversified tendency undertaken under a misguided notion may result in is well illustrated in the following reply recently received to an advertisement for a man having a good knowledge of railroading with some experience in the mechanical department: "I am an all-round railroad man experienced in all branches, viz, conductor, brakeman, fireman, engineer, track foreman, yard master, train master, despatcher, master mechanic, superintendent, maintenance of way, accountant, paymaster and detective." While the applicant further states that he can do anything desired, his proficiency in any line whatever would, of course, be seriously questioned. It would be well to bear in mind the fact that while executives have usually a surprisingly intimate knowledge of the conduct of every department, they have generally acquired this through keen observation and study in preference to the process of rotating from one department to another, which is often more demoralizing than helpful. Success depends so largely upon the tangible value of your services to your superior officers that a very thorough knowledge of just one feature may be put down as the most important single qualification.

Permanent Improvements to Cars

The railroads are bending their energies to getting the maximum mileage from all freight equipment. While the immediate necessity for more transportation justifies any measures that can be taken to meet the situation, the consequences may be serious unless the needs of the future are considered. There is no prospect that the amount of freight which the railroads are called on to handle will decrease. Cars which make unusually high mileage are sure to wear out with unusual rapidity and precautions must be taken to prevent cars being kept in service when in need of extensive repairs lest the roads find themselves at some future date handicapped by a large amount of freight equipment in a deteriorated condition.

The obvious remedy for this condition would be the immediate purchase of large amounts of new equipment, but with the present serious shortage of freight cars the existing equipment must be kept in service whether or not new cars are acquired.

While some roads have such a large proportion of bad order cars that no heavy repairs can be made with the existing forces and facilities, the roads that have reduced the bad order equipment to a reasonable percentage should put in effect a program for the reinforcing of equipment. This work should have for its object the elimination of all the troublesome defects that have developed in service. Not only should steel center sills or metal draft arms be applied where necessary, but the cars should be equipped with thicker end lining and steel end and corner posts or all steel ends. Roofs of substantial construction should be applied and the superstructure should be reinforced when necessary to avoid distorting the roof sheets. Side doors with steel frames and adequate door fixtures will eliminate many a damage claim and many a trip to the repair track. The trucks should not be overlooked; safety hangers for the brake beams should be applied where needed; side bars should receive attention; the weak truck bolsters should be replaced. The reduction of bad order cars to a maximum of 4 per cent is a praiseworthy object, but the emergency is not great enough to justify any road in meeting the situation by disregarding sound policies in the current maintainance of its car equipment.

Breaking Transportation Records

The fact that transportation is a limiting factor in the output of some of America's important industries has been stressed so often that it hardly needs emphasis. The difficulties of the early months of this year caused a falling off in the traffic handled, but with normal conditions restored the roads have been steadily increasing the amount of freight hauled. During the week of August 14, the number of cars loaded was 962,352, an increase of 129,913 cars over the corresponding week of 1919, and of 13,556 cars over the corresponding week of 1918. This is a new high record for this season of the year.

In order to better this, if possible, the Association of Railway Executives has set as a definite goal the following performance: 1—An average daily minimum movement of freight cars of not less than 30 miles per day; 2—An average loading of 30 tons per car; 3—Reduction of bad order cars to a maximum of 4 per cent of total owned; 4—An early and substantial reduction in the number of locomotives now unfit for service; 5—More effective efforts to bring about the return of cars to the owner roads.

Of these five factors which contribute to the operating efficiency, the third and fourth are matters for which the mechanical department is directly responsible.

The number of bad order cars is still very large and every effort must be made to get the cars into service. The roads should not hesitate to seek assistance from car building plants that may have excess capital available for repair work if they cannot reduce the percentage of bad order cars with their own forces. The report of locomotives out of service for repairs shows that the motive power on some roads is in excellent condition. Other roads have a high percentage of engines awaiting classified repairs. With labor available, the roads that are hampered by lack of serviceable power should add to the forces to improve conditions before winter weather increases the amount of maintenance work.

The Use of Micrometers

Are micrometer calipers an unnecessary refinement for railway shop work? Is it true that railway mechanics are not qualified to use any instrument more accurate than a two-foot rule? Both of these ideas have become so firmly imbedded in the minds of some people that it is difficult to dislodge them, but we feel that the correct answer to both questions is a decided "No." This belief is substantiated by the conclusions reached in an article entitled "Micrometer Calipers in Railway Shops" appearing elsewhere in this issue. The author of the article is a practical railway shop man of many years' experience, who maintains that the more general use of micrometer calipers will improve both the quality and quantity of shop output. Many important arguments are presented and detailed illustrations given to show how the use of micrometers on various classes of work will tend to produce the results predicted.

As an example of the way in which improved quality of work can be obtained the author cites the many force fits that must be made in locomotive repair work. It is pointed out that the safety of passengers and trainmen depends upon axle fits in wheel centers, which can be made most accurately when micrometer calipers are used in measuring. Some parts of locomotive motion work must be provided with running fits within certain limits. When these fits are too tight, the results are as serious as when too loose, and the exact amount of play, demonstrated by experience to be correct, can best be measured with micrometers. The use of micrometers in railway shops also makes possible more accurate measurements on many other classes of work. Mechanics can tell exactly how close they are working and

the results will be a general toning up and improvement in workmanship.

It was stated that shop output is increased in quantity, due to the fact that machine parts may be calipered more quickly with micrometers than with ordinary calipers and a scale. By having all measurements of similar work made by one man and recorded on suitable forms, machine operators can remain at their stations and thus reduce the idle machine hours. Micrometers also make possible greater accuracy in machining and therefore eliminate many scraping operations. For example, driving box brasses can be bored a limited amount larger than the journals and applied without further scraping or fitting, experience having demonstrated that no unsatisfactory results will follow. The reduction in the number of solid ring gages required, the tendency to eliminate disputes between inspectors and workmen and other important results of the use of micrometers are also pointed out in the article.

Fads and Facts About Fuel

Although staggering under an appalling fuel bill, how many railroads are making a consistent and persistent effort to reduce this bill, and how many of these have organized this effort on the same stable basis that characterizes the conduct of other departments? How many executives regard the fuel department as a fad, how many consider it a necessity? Nowhere will organized effort count for more than when directed towards fuel conservation on our railroads. But as long as supervision is regarded as a fad, so long will it remain a failure. If the management were dissatisfied with the operating department or with the mechanical department it is possible that they would make some change, but certainly they would not dispense with the organization even if that were practical. Yet every turn in the affairs of many railroads affects the mode of fuel supervision and fuel departments come and go as regularly as the tide. The railroads must consider fuel supervision as something more than a fad, they must organize this work on a sound basis and stick by the organization if they expect to stem the rising tide of fuel costs.

NEW BOOKS

Tin, Sheet Iron and Copper Plate Worker. By Leroy I. Blinn. 5 in. by 7 in., illustrated, bound in cloth. Published by Henry Carey Baird & Co., 2 West Forty-fifth street, New York.

This book can best be classed as a reference volume for engineers, foremen and mechanics who have to do with sheet metal working of any description. It could also be made use of as a text on this subject and will afford interesting reading to anyone versed in the manipulation of sheet metals, though it is primarily a handbook designed for the guidance of workers in sheet metal. As such it is eminently practical and deals most thoroughly with every phase of this work. Particular attention is given to the rules for laying out work of all descriptions, the composition of metallic alloys and solders, recipes for varnishes, lacquers, cements and so on. All the manipulations encountered in the work shop are described quite definitely. As this book is a revised edition of an earlier publication it may be added for the benefit of those who are familiar with the previous edition that the new edition contains all the fundamental subject matter appearing in the original publication, augmented by data on the modern system of triangulation as related particularly to skylight work. Moreover, the portion of the earlier edition treating on metallic alloys and solders has been entirely rewritten so as to incorporate the best modern practice. The subjects are systematically grouped and a complete alphabetical index adds to the value of the book as a reference volume.

COMMUNICATIONS

HANDHOLDS VS. WASHOUT PLUGS

Omaha, Nebr.

To the Editor:

Referring to the editorial Accidents Due to Washout Plugs, appearing in your January number and the articles by Mr. Lipetz and Mr. Grant in your April and June issues respectively pertaining to this subject.

The ordinary plugs in general use in this country were inherited from our very first locomotives which carried low boiler pressures and were built before the advent of the tube supported fire-box brick arches, which requires from 4 to 12 additional plugs, according to the width of the fire-box. The use of these plugs has been continued, probably due to the fact that they are simple and inexpensive in first cost, but it should be apparent to anyone familiar with the subject that they are inefficient and are not meeting modern service requirements. The final threads in the boiler sheets, being exposed when the plugs are removed, are subject to wear and damage by the insertion of the boiler washout implements. Further, the threads become clogged with dirt and scale from the boiler, resulting quite often in crossing the threads when the plugs are screwed in place.

When these plugs are located in the curved corners of the fire-box, usually not more than two full threads of the plug engage the sheets, and in order to obtain even this small number of threads the plug is limited to two inches in diameter and 12 threads per inch.

The Pennsylvania Railroad has used for a number of years, and to a considerable extent, handholds similar in general construction to those described by Mr. Lipetz, with the exception that they employ special asbestos gaskets instead of the lead gaskets. This type of handhold undoubtedly provides a more safe form of construction than the ordinary washout plug, but it is more troublesome to handle, and more costly.

Another type of construction which has been used to a limited extent in this country consists in flanging out and threading the fire-box sheets around the washout holes, and inserting the ordinary plugs, but this arrangement has practically all of the inherent defects of the ordinary plugs and the disadvantage that the sheets are materially reduced in thickness and weakened by the process of forming the flange as described.

Attention is invited to the form of washout plug illustrated by the accompanying sketch, which is self-explanatory and which was developed and patented by Messrs. Gilmore and Woodward, engineers of the American Locomotive Company.

The sketch shows the plug applied at the corner of the fire-box, but the same arrangement can be used on flat surfaces and for arch tube plugs. The square portion of the plug, provided for receiving the wrench, is shown extending outwardly, but it can be countersunk if desired into the outer end of the plug, thereby making the whole arrangement more compact.

It is understood that about 150 locomotives, built in this country, mostly for service abroad, have been equipped with these plugs, but I have no actual information as to how the plugs have met the service conditions.

With this plug the usual boiler cleaning tools could not damage the threads, nor could they become clogged with dirt from the boiler, and as relatively coarse threads could be used on the cap it is thought that little trouble should be experienced with crossed threads. It is simple in construc-

tion, should be reasonable in cost, and could be readily handled.

As accidents due to washout plugs are on the increase, and as it is generally admitted the plugs in common use are not meeting present-day conditions, the matter is of importance and it would seem that it should be given serious consideration by all concerned and especially by the committee on Design and Maintenance of Locomotive Boilers, of the American Railroad Association.

JOHN L. MOHUN,
Mechanical Asst. Union Pacific System.

FAIR PLAY FOR THE SERVICE OF SUPPLY

TO THE EDITOR:

Your editorial on the Service of Supply, appearing in the May issue of the *Railway Mechanical Engineer*, attracted my serious attention and I have read the subsequent correspondence which developed in connection with this editorial with more than usual interest.

It appears to me that in the first place much of the misunderstanding referred to between the mechanical and the stores department is in a large measure due to non-comprehension on the part of the mechanical department of the aim and purpose of the Service of Supply. This department fully appreciates that the mechanical department must have the material with which to work and it is never the purpose of the stores department to embarass the operation of the mechanical department by restricting the supplies of material furnished to this department. The quantity of these supplies is always limited by two very important factors; the availability of the material and the financial resources of the railroad. During times such as we have been passing through, it has often been exceedingly difficult to obtain the materials which are needed by our shops. This applies particularly to steel products of which there has been a great scarcity in many lines.

Unapplied material is money, and the purchase of material represents an investment. If the railroad can use this material as soon as it is delivered, it is a very profitable investment. But if the material lies around unused for months because the railroad has more of this particular kind of material than it needs, or because the mechanical department has changed its plans and has decided to use some other kind of material as frequently happens, then it is a very bad investment and, of course, the Service of Supply is blamed because it must continue to carry this material and absorb the loss due to the interest on the investment and the inevitable depreciation of the material which may be accelerated by obsolescence. But whether the investment be good or bad, it must invariably be proportioned to the financial resources of the railroad. There are many things that you need, both in your business and in your home, things that, if purchased, would save you a great deal of money or increase the enjoyment of your home, but if you do not have the money, you must forgo their purchase. This is frequently the situation in which the railroad finds itself and not unfrequently it is the Service of Supply that is blamed by those who have asked for the material.

One of your correspondents has, if I have not misunderstood him, suggested that the railroad should proceed with the purchase of needed material without regard to its financial resources and depend upon its enhanced earning capacity to create the necessary credit. If matters were as simple as this there would have been no occasion for the railroads to plead poverty before the Interstate Commerce Commission or any real necessity for the recent rate increases to correct a situation that has been fundamentally responsible for the inability of the railroads to properly provide for their needs.

There is, of course, another factor to be reckoned with in any consideration of this subject and that is the efficiency of this much abused Service of Supply. This has an all important bearing on delays to equipment undergoing repairs; which, after all, is what the mechanical department is most concerned about. A simple statement of the facts will serve to illustrate my point and possibly convince some of the mechanical fraternity that what is really needed on every railroad is a strongly organized Service of Supply and that this is the best possible insurance against delays attributable to shortage of material.

"During the period of federal control, the inspectors of the mechanical division were instructed to report to headquarters all shop delays with their cause and duration. All delays attributable to shortage of material were at once reported to the Division of Purchases and were immediately investigated thoroughly on the ground and the conditions remedied. Out of scores of such reports received from all over the country, indiscriminately, only one report referred to conditions on a railroad which has had a properly organized supply department operating for any length of time."

GENERAL STOREKEEPER.

STANDARD METHOD OF PACKING JOURNAL BOXES

TOPEKA, Kan.

TO THE EDITOR:

There were two elements in the discussion of the use of the front plug in the journal box at the A. R. A. Convention that apparently were overlooked. First, the figures quoted on the increased car miles obtained per hot box by leaving out the end plug compared a period when all boxes were repacked with a period when the journal boxes ran until they gave trouble or the car was sent to the shop for repairs. These two periods are not comparable. Second, approximately 40 per cent of all hot boxes have other troubles than poor packing as the cause of their running hot. If the car trucks were given attention many of these defects would be automatically rectified.

The only use of journal box packing is to lubricate the journal. The absorbent power as well as the capillary power of the waste are the only qualities that directly affect the lubricating capacity of the waste. Resilience is an important mechanical characteristics of any good journal box packing. Two journal boxes with equal qualities of waste and packed in the same manner will give equally satisfactory service, other conditions being equal. The condition of the packing under the journal is the essential thing. The use or non-use of a plug in the end of the box does not affect the lubrication of the journal until some other condition obtains. If no end plug is used in the box the packing must be set up each trip or each division. If a plug is used the box will run a much longer time without any attention. It is a question of labor pitted against the plug.

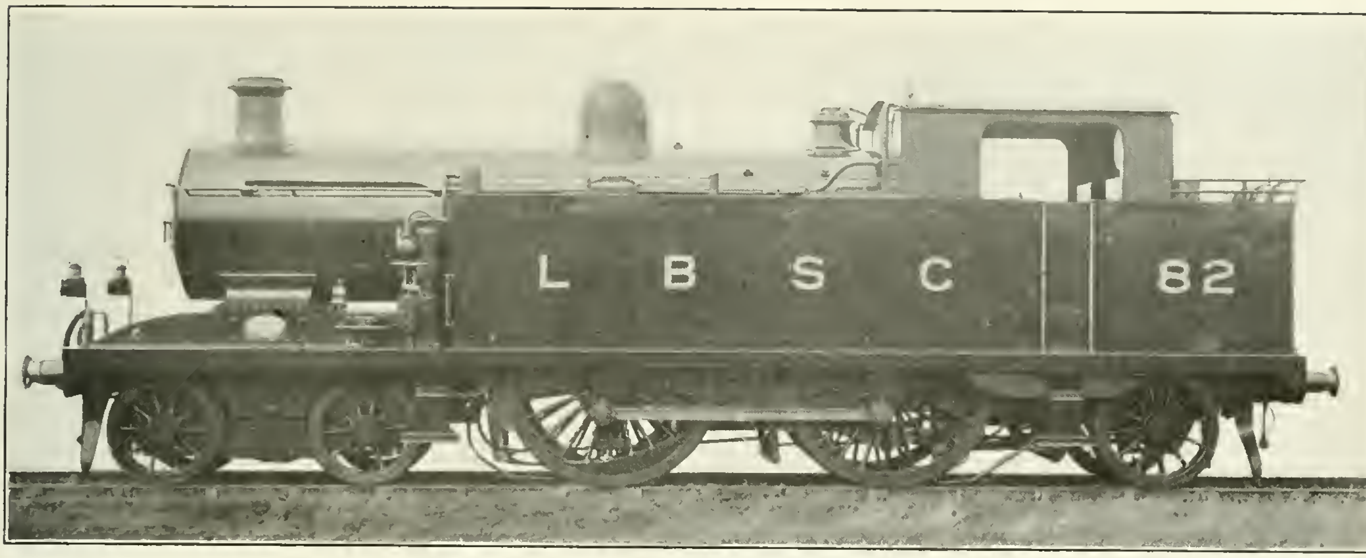
Briefly, the arguments for and against the use of the end plug are as follows:

Arguments Against the Use of the Plug. 1. The box can be better inspected without the plug. 2. The saving of material by leaving the plug out.

Arguments for the Use of the Plug. 1. The plug holds the packing under the journal if properly applied. 2. The plug is an additional oil storage for the lubrication of the journal. 3. The plug will assist in keeping dust from the packing underneath the journal.

If all journal boxes were repacked periodically the packing should always be in good condition and there would not be so much hot box trouble. This repacking must be done in a conscientious and thorough manner to accomplish the desired results.

H. L. SHIPMAN.



One of 42 English Tank Locomotives Equipped with Feed Water Heater as Detailed in Fig. 8

LOCOMOTIVE FEED WATER HEATING IN EUROPE

The High Price of Coal Has Stimulated the Use of This Appliance; Over 10,000 Units in Operation

BY ROBERT E. THAYER

European Editor of The Railway Mechanical Engineer

WITH the present cost of coal anywhere from 200 to 1,600 per cent of what it was before the war, the railways of Europe have been forced to consider very carefully means by which locomotives can be operated with a decrease in fuel consumption. Superheating is, of course, quite universally adopted although in England this method of saving fuel has not been developed to the same extent as on the railways in the United States. The use of feedwater heaters is one means of fuel economy which is now receiving the greatest attention particularly on the Continent. It is estimated that there are over 10,000 feedwater heaters in use on the railways of Europe. These are distributed amongst the Weir system, the Caille-Potonie system and the Knorr system, the latter having by far the greatest distribution. The Weir system is confined almost entirely to Great Britain, the Caille-Potonie to France and the Knorr to Germany, Holland and Switzerland.

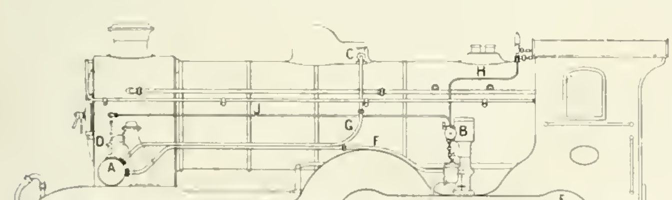


Fig. 1—Arrangement of Weir System of Feedwater Heating

The Weir System

The Weir system of feedwater heating consists of a double-acting steam feed pump which takes the water cold from the tender through the pipe *E* forcing it through the heater *A* into the boiler through the discharge pipe *G* as shown in Fig. 1. The pump is of a vertical type and is of a design largely used in marine service. The heater is shown diagrammatically in Fig. 2. It consists of a bundle of tubes of solid drawn copper expanded into tube plates *E* of rolled brass. These tube plates are fixed to the ends of a mild steel shell by collar bolts which also carry the end covers of the heater. The covers contain dividing ribs which cause the feed water to flow from end to end of the heater, making four passes. The exhaust steam from the cylinders enters the heater at *B* and from the pump at *C*. Thus it will be seen that the exhaust steam surrounds the tubes and with the feed pump between the heater and the tank the heater is subjected to boiler pressure.

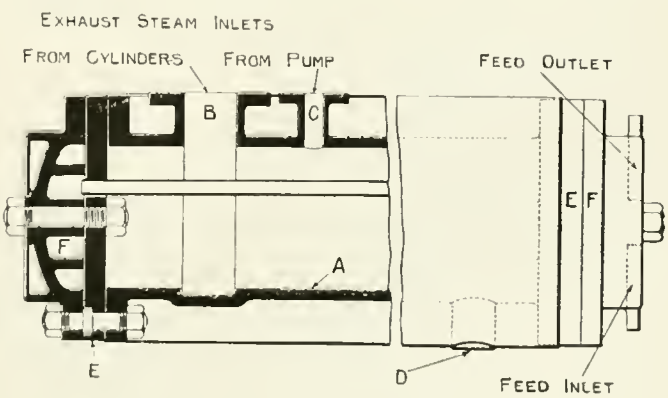


Fig. 2—Weir Locomotive Feedwater Heater

The Caille-Potonie System

The Caille-Potonie system is of the open type, the water flowing from the tank to the feed water heater by gravity, a hot water pump being used to take the heated water from the heater and pump it into the boiler. A diagrammatic out-

line of a recent installation is shown in Fig. 3. The water from the tender passes through the pipe *M* to the "Y" fitting *P* which delivers the water to the top and bottom of the heater. The heated water is taken off at *J* passing through the pipe *Q* to the pump *S*. From there it passes through the pipe *T* to a check valve and into the boiler.

The exhaust steam for heating the feed water is taken from the exhaust nozzle *A* passing through the pipe *C* to the heater. The exhaust from the feed pump also passes to the heater through pipe *X*. The amount of exhaust steam to be taken from the exhaust pipe is regulated by a deflector valve which is set to deflect the proper amount of steam to the heater. The heater itself is kept at atmospheric pressure, a pipe R extending up from the top of the heater to above the water line in the tender. This not only provides a means of overflow for the heater but also permits the air and gas formed in heating the water to escape. A spring regulator valve is shown at *D*. This is placed in the pipe *C* between the heater and the exhaust pipes and is so regulated that when the pressure of the exhaust steam in pipe *C* exceeds a predetermined amount the supply of exhaust steam to the heater is reduced. Its purpose is to prevent the feed water in the heater being raised to too great a temperature for the pump to handle. The pump, however, is designed to handle water with a temperature of 209 deg. F. without a loss in its efficiency. As the temperature in the feed water heater increases the pressure of the exhaust steam in pipe *C* increases and overcomes the spring of the regulator valve and thus reduce the supply of the exhaust steam to the heater. A pyrometer is placed in the heater discharge pipe, the wires of which pass through the conduit *3* to a gage in the cab. A connection is made in the delivery pipe *T* and piped through *I* back to the cab to a gage which indicates the pressure of the feed water in the delivery pipe. Another connection is made in the delivery pipe for sprinkling the coal in the tender, the water passing up pipe *6* back to a tap in the cab.

The heater itself is shown in Fig. 4. The water surrounds the tubes and the exhaust steam passes through them. Entering at *A*, it makes three passes through the heater, the condensed water passing out through the bottom at *B* and on to the track. The heater is provided with a settling basin which catches the precipitation of any scale forming matter

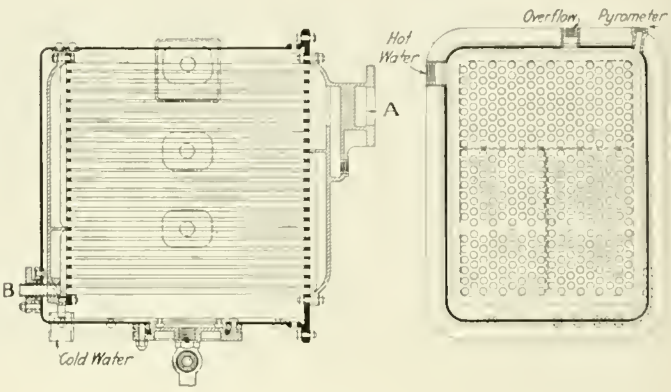


Fig. 4—Caille-Potonie Locomotive Feedwater Heater

as the water is heated. This basin has a cleaning hole as indicated in the drawing by means of which it can be cleaned every 400 or 500 miles depending upon the character of the water handled. The hot water steam pump in this system is located on a level with the feed water heater in order to reduce the lift to a minimum.

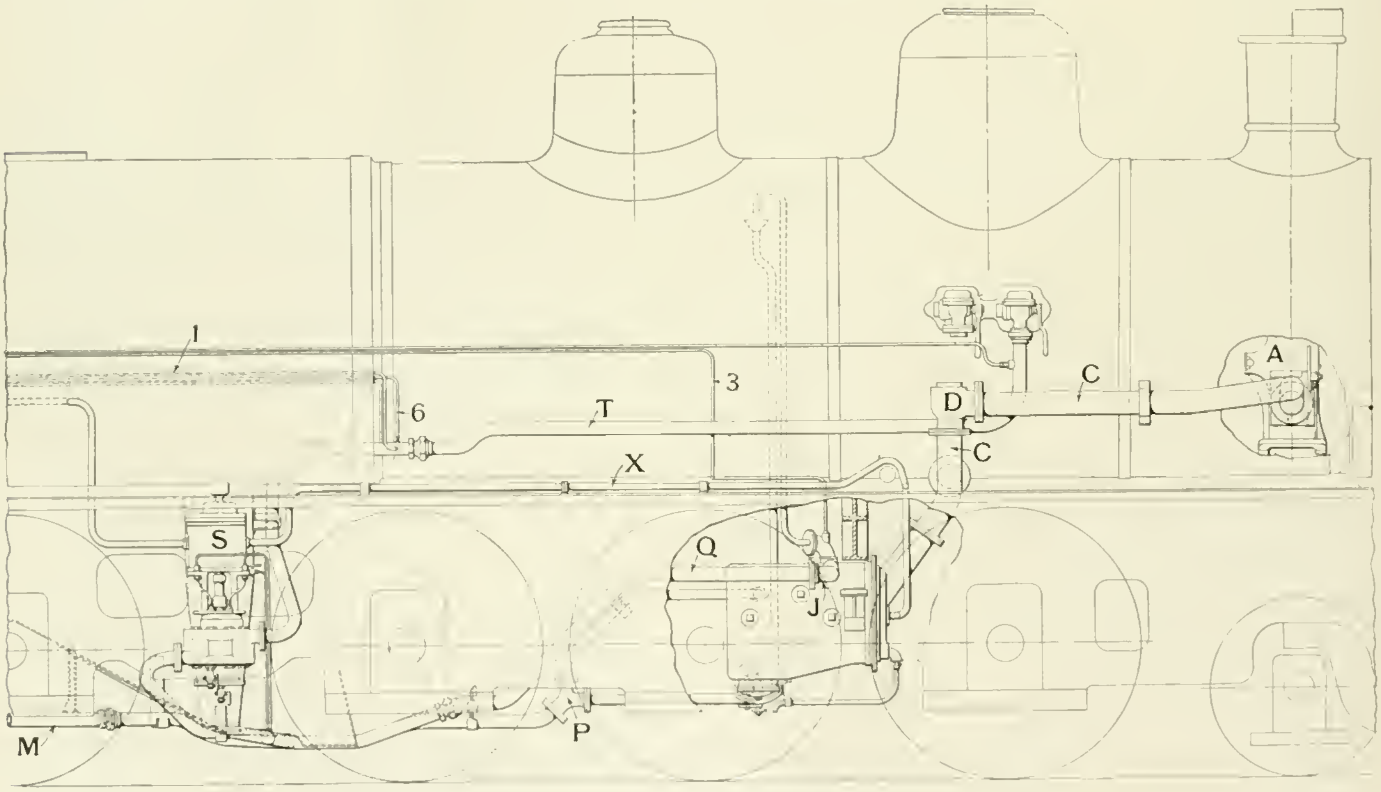


Fig. 3—Arrangement of the Caille-Potonie System of Feedwater Heating

The Knorr System

The Knorr system operates with the heater under pressure, the pump being placed between the heater and the tank. Fig. 5 shows the general arrangement of this system. Water from the tender passes to the pump *M* and from there to the heater *A*. being delivered from there to the boiler through pipe *F*. The exhaust steam is taken from the exhaust passages of the cylinder castings at *G* passing through

the pipe J to the heater. Exhaust steam from the air pump passes into the heater through the pipe L and the exhaust steam from the feed water pump passes to the heater through the pipe K. The condensate from the heater passes to the track through the pipe R. An oil pump for lubricating the

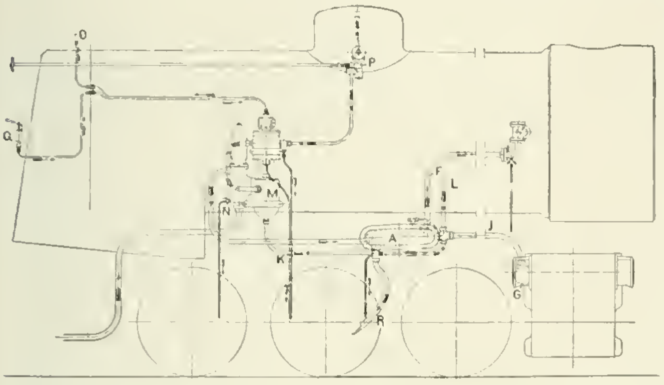


Fig. 5—Arrangement of Knorr System of Feedwater Heating

feed water pump is shown at Q and O is a counter registering the number of the strokes of the feed pump. At P is located the steam valve for operating the feed pump. This is controlled, as indicated, from the cab.

This diagram shows a flat feed water heater which is one of the earlier types made but the present standard heater is circular in shape as shown in Fig 6. Also the condensate

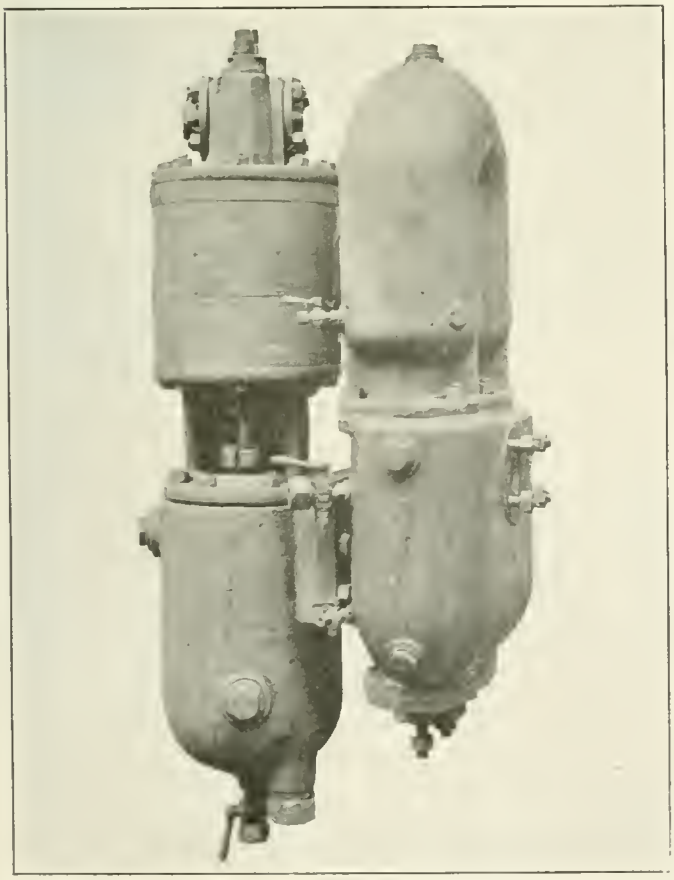


Fig. 6—Knorr Locomotive Feedwater Pump

is shown as being discharged on to the track. More recent installations are arranged for the condensate and steam passing through the heater to discharge into the ashpan. This diagram also shows exhaust steam being taken from the exhaust passages in each cylinder but there are installations which take the exhaust steam directly from the exhaust pipe.

The heater as shown in Fig 6 consists of a bundle of U-pipes which are held in only one tube plate. The water passes through these tubes making four passes, and the exhaust steam surrounds them. The water enters the heater at A and is discharged at B. The exhaust steam enters at CC and the condensate flows out at D. The construction of this heater is such that all of the tubes can be removed intact with tube plate when it is desired. All of the tubes are bent to the same radius and are interchangeable. Any individual tube can be removed and replaced although it will be shortened by the length of its former bearing in the tube plate. With bad water difficulty is experienced in keeping these tubes clean on account of the U-shaped ends.

Development in England

In England but little has been done recently although there is a tendency to seriously consider the application of feed water heaters to locomotives on account of the increase in the cost of fuel. The cost of locomotive coal has increased about 100 and 120 per cent. Almost every road has at some time or other done some experimenting—usually before the war. However at the present time but few locomotives are equipped. Out of twelve railroads, five have none installed, one road has one, two have two, one has five, one has fifty-three and two have some but the number was not stated.

Following are quotations from some of the replies to a letter of inquiry on this subject:

Road A—Our experience with locomotive feed water heaters has been limited to two installations. The results have been satisfactory, there being about 8 per cent saving in coal and 5 per cent in water.

Road B—We equipped five locomotives with feed water heaters in 1912. They are still in service and do not give any particular trouble. However the slight saving obtained

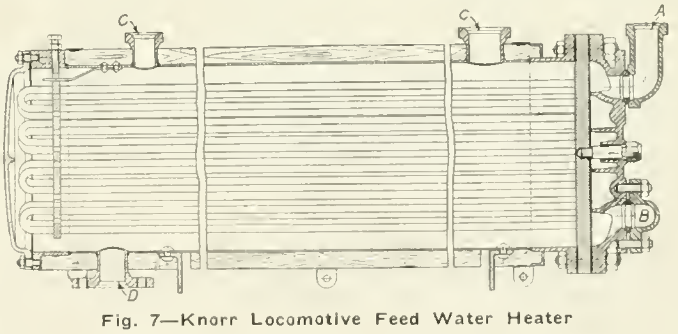


Fig. 7—Knorr Locomotive Feed Water Heater

does not cover interest and depreciation on the first cost, together with repairs.

Road C—We have one locomotive fitted with a feed water heater. In the January, 1914, some tests were made with our dynamometer car while the engine was hauling a passenger train in one direction and a freight train in the opposite direction. There was no appreciable difference between the injectors we are at present using and the feed water heater as fitted.

Road D—Fig. 7 shows a 4-4-2 type side tank passenger engine fitted with a feed water heater. Exhaust steam from the cylinders is admitted to the water tanks through the pipe A, the flow of which is controlled by a butterfly valve located at B and operated from the footplate. The temperature of the water is thereby rapidly raised, and as the hottest stratum lies at the top it is drawn off through the tubes C adjusted to the water level by a copper float, which is hinged at D thus allowing water to be taken at all levels by means of the "Weir" feed pump E and delivered

to the boiler through an ordinary check valve *F* at an approximate temperature of 180 degs. F. This pump can be set to discharge into the boiler just as much water as is being evaporated and is capable of going very slowly without actually stopping. It is driven by steam and the exhaust is utilized to heat the water in the tanks through pipe *G*. A supplementary heating ejector *H* is also fitted and takes steam from the boiler by means of the steam valve I. This is used to heat the water when the engine is being prepared for its day's work, and after it has generated sufficient steam. It is also used in turning the surplus steam into the tanks when the fixed boiler pressure is exceeded, and steam is being blown off at the safety valves. This railroad has 42 engines fitted in this manner.

A similar arrangement of feed water heating is used on ten 4-4-2 tank engines, but in this case the delivery from the feed pump is taken to the check valve *F* fitted on a feed dome on the top of the boiler (Fig. 8). The water at a temperature of approximately 180 degs. *F* enters a closed drum at the center of the feed dome and clear of the delivery pipes *LL*, these being placed at the sides. As the drum fills the water overflows into the delivery pipes *LL* and passes into the boiler. The drum is made deep so that the sediment may be deposited at a sufficient depth from the mouth of the delivery pipes, as it has been found in the shallow domes that, owing to the velocity of delivery, a great bulk of the sediment is carried over into the boiler. A shield plate *M* is fitted over the steam pipe and as the water falls onto it from the pipes *LL* it divides into streams which allows it to attain very quickly a temperature equal to that in the boiler. This arrangement has given entire satisfaction.

Road E—We have for many years used the exhaust steam injector, the economy from the use of which we estimate to be between 8 and 10 per cent of coal.

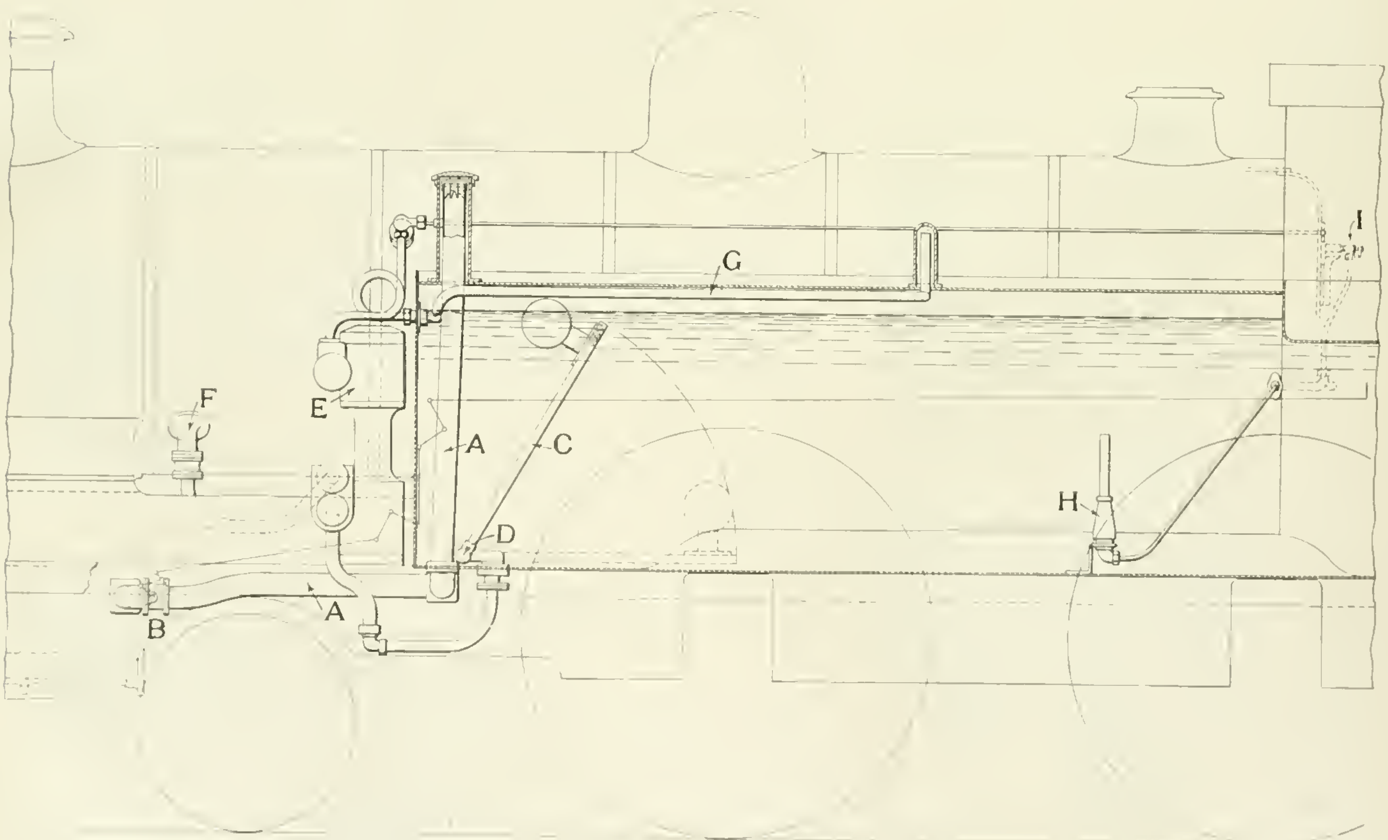


Fig. 8—Feedwater Heating Apparatus as Applied to English Tank Locomotive

Feed Water Heating in France

The principal source of information regarding the development of locomotive feed water heating on French railroads was obtained from the manufacturers of the Caille-Potonie System. There are 146 of this type of heater in use, with 272 on order in France itself. There are 20 in Tunis, 8 in Belgium, 50 in Roumania and 3 in Turkey. *Recent tests made by a prominent French road with the apparatus shown in Figs. 3 and 4 have shown a fuel saving of 17.8 per cent in fuel consumption per 100 ton-kilometers over the same locomotive using the injector and there was an increase of 22.3 per cent in evaporation.*

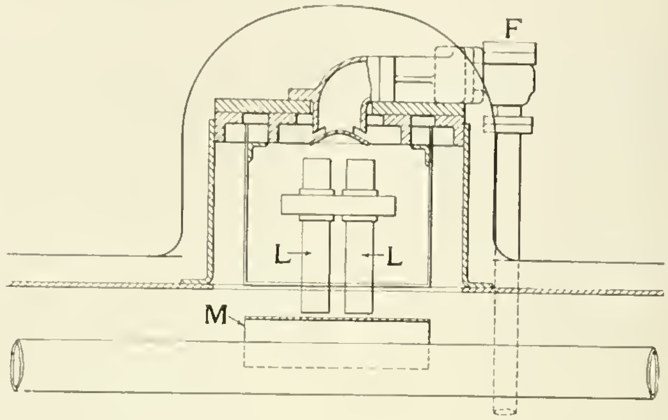


Fig. 9—Feed Dome for Feedwater Delivery

The cost of locomotive coal in France has risen over 700 per cent and there has been a manifest interest in feed water heating as shown by the large number of feed water heaters on order.

Feed Water Heating in Belgium

The following abstract of a letter from Belgium indicates clearly the situation there.

Before the war we had decided to experiment with various systems of feed water heaters. Our object was not so much to find out what economy could be effected by the use of pre-heaters to a locomotive—the importance of which economy is incontestable—as to compare the systems in question from the point of view of efficacy, smooth working and upkeep. The war prevented us going on with the matter.

Among the locomotives supplied to us by the Germans in virtue of the terms of the armistice, a fairly large number are fitted up with the Knorr heaters. The present condition of the service has not permitted us to try experiments with a view to determining the economies resulting from its use. The Knorr apparatus has caused a certain number of mishaps specially affecting the heater tubes. At the beginning some difficulties were met with on account of the inexperience of the staff, but these have now disappeared.

With the view to making comparisons we have also decided to fit feed water heaters to some of the locomotives which are at present in the course of construction. Ten of the Consolidation locomotives which are ordered from England will be fitted with the "Weir" heater and five of the Consolidated locomotives ordered from America will be fitted with the "Worthington" heater.

Feed Water Heaters in Holland

The railways of Holland have also a "coal problem." The price of locomotive coal has increased about 1,200 per cent from since before the war, and locomotive feed water heating has become very popular. This country uses the Knorr system entirely. There are about 300 locomotives out of a total of about 1,000, that are equipped and the present program calls for the application of heaters to all of the principal locomotives. This includes locomotives weighing from below 50 tons to the heaviest locomotive of 102 tons. The railways in Holland have made no conclusive tests with the feed water heater but it is claimed that a feed temperature of from 190 to 210 degs. F. is obtained.

Feed Water Heating in Switzerland

The situation in Switzerland is well outlined in the following abstract of a letter from the chief mechanical engineer of the Swiss Federal railways:

The first experiment with locomotive feed water heaters on the Swiss Federal railways was undertaken on a new 4-cylinder simple, superheated locomotive, which was put into service at the end of 1913. The locomotive was fitted with an exhaust steam and smoke box heater in conjunction with a Westinghouse feed pump. This experiment was not satisfactory; the exhaust heater was much too small, it required much repairing on account of faulty construction, the smoke box heater hindered the passage of gases so much that to obtain a sufficient head of steam about half the tubes of this heater had to be removed, so that the heating surface was reduced from the original 253 sq. ft. to 134 sq. ft. This feed heater also required much repairing, as the thin tubes became bent and cracks appeared in them. In 1915, therefore, both feed-heaters were removed, the exhaust heater with the feed pump being applied to a smaller superheated compound locomotive for which it is suitable.

At the beginning of 1915 two new superheated compound locomotives were put into service with exhaust feed heaters; one locomotive was fitted with a Westinghouse feed pump and a feed heater from the Winterthur Locomotive Works, the other with a Knorr feed pump and Knorr feed heater. Both arrangements have proved successful.

On the trial runs, which were carried out on the section Erstfeld-Göschenen (Gotthard railway), with a continuous ascent of 2.5 and 2.6 per cent, *a saving in coal of about 10 per cent per 100 ton-kilometer was established for engines with feed heater in comparison with engines of similar construction without feed heater.* The performance of the engines have been improved quite considerably in consequence of the installment of feed heaters. Therefore the 15 superheated compound locomotives delivered in 1916 and 1917 have all been fitted with exhaust feed heaters, and feed pumps. Old Westinghouse air pumps have been used, with their air-cylinders replaced by water cylinders in conjunction with a suction chamber. In the meantime, for the remaining 11 superheated compound locomotives feed heaters of the Knorr pattern have been ordered.

It has been found that the saving from feed heating on locomotives traveling chiefly on lines with alternately rising and falling gradients is small. The feed heaters are only suited for long sections which are run under steam.

There are in all up to the present 21 locomotives already provided with feed heaters and 11 others are shortly to be fitted with them.

Development in Germany

Locomotive feed water heating in Germany is now as common as superheating in the United States. It is estimated that there are over 10,000 locomotives so equipped. It is not an after-the-war development there, for as early as 1909 the German railways began investigations and installations on a large scale were made soon after that. The Knorr system was adopted as standard and by the end of 1912 about 3,000 heaters were installed. At the present time there are well over 10,000 in operation and they are being applied at the rate of 2,000 a year. All new locomotives are equipped with this device and many old locomotives. With coal costing 200 marks now, as against a price of 12.5 marks before the war, it is estimated that the feed water heaters pay for themselves through the economies effected in less than one year.

The only test data available in regard to this system of feed water heating are the results of tests made in 1913 on a passenger locomotive (Type 2-B) over a distance of 91 miles between Grunewald, just outside of Berlin, and Gusten. Three tests were made, one without the heater—Test A—one with the heater—Test B—under the same conditions as test A, and the third—Test C—with the heater and a heavier train. During test C two more stops were made than in test A and B, but notwithstanding this fact the running time of test C was less than either tests A or B. The following table gives a summary of the results of these tests:

	Test A	Test B	Test C	Percentage Difference B over A	Percentage Difference C over A
Feed water heater........	No	Yes	Yes		
Running time (min.)... ..	129	131	125	1.5	—3.1
Train load (tons)........	348	348	353	...	1.4
Coal consumption (lb.)....	5,672	4,300	5,400	—24.3	4.8
Ton-miles per lb of coal...	5.59	7.37	5.95	31.8	6.4
Water consumption (lb.)..	31,000	31,900	36,100	9.2	16.4
Evaporation	5.45	7.42	6.68	36.1	22.6
Coal per sq. ft. of grate area per hr. (lb.).......	108.5	80.9	106.5	—25.4	—1.8

It will be observed that there is a decided increase in the efficiency of the locomotive in Test B over that in Test A, although the same load was hauled. Test C indicates that even a heavier load can be hauled when the feed water heater is used, with a decrease in fuel consumption and an increase in evaporative efficiency, than when the heater is not used.

The service rendered by the heaters has done much to relieve the severe locomotive shortage the German railways experienced after the war. In a paper before the Verein Deutscher Machinen-Ingenieure in December, 1912, Gustav Hammer, who is now the chief locomotive engineer of the Prussian-Hessian System, said that the principal reasons for the rapid introduction of feed water heating by exhaust steam are the greater economy obtained by the saving of coal and the increase of efficiency without the weight of the en-

gines being increased much. The greatest economy in coal is naturally obtained with engines having the highest steam consumption and such engines cause a heavy strain on the boiler. The economical results obtained are not only due to the fact that a large amount of the heat from the exhaust steam is reclaimed, but also because it reduces the rate at which the fuel is burned on the grate. Both of these factors increase the efficiency of the boiler. *According to the conditions of the traffic the saving of coal varies, but, on an average, it may at least be 10 per cent.*

More important still is the increase of the efficiency of the engine as a whole. If the friction weight and the efficiency of the machine are sufficient and only that of the boiler fails this can be quite considerably increased by feed water heating. This is especially important for lines the permanent way and bridges of which do not allow a special increase of wheel loads. The tests of the Royal Railway Central Office, which were very thorough, have shown increases of the efficiency of the boilers of 20 per cent and more, in a way that cannot be disproved. In particular, these tests have shown that, with superheated steam engines, under otherwise identical circumstances, the production of steam can be increased from 12.5 lb. to 15.4 lb. per sq. ft. per hour by exhaust steam heating.

The preservation of the boiler is to be considered as a further very great advantage of the feed water heating. This preservation is, first of all, brought about by the smaller heating surface required with the same efficiency in comparison with the ordinary engine as about 1/6 of the heat contained in the exhaust steam is regained. It further results from the difference in the feeding of the boiler as well. When using the heater, the supply of feed water must be adapted to the consumption as exactly as possible. It is not an intermittent feeding, but a continuous one by the steam feed water pump, which can be adjusted very easily, and within any limits. It is not the same with the injector. Furthermore, the boiler is supplied with water at a lower temperature with the injector than with the heater. The boilers properly fed with heated water must be considerably better and have a greater life than those fed with injectors only.

MOUNTAIN TYPE FREIGHT LOCOMOTIVES FOR THE SOUTH AFRICAN RAILWAYS

While it is true that locomotives built in accordance with American practice have demonstrated their fitness for service in all parts of the world, there are many railways which, for good and sufficient reasons, when purchasing locomotives from builders in the United States, specify that European designs be followed. American builders have had considerable experience in work of this kind, even to the extent of building locomotives throughout to the metric system of measurement.

The Baldwin Locomotive works have recently constructed thirty locomotives for the South African Railways, built throughout in accordance with the railways' designs and specifications. The South African lines are built to a gage of 3 ft. 6 in., and in view of the narrow gage and clearance limits, the motive power is conspicuous because of its exceptional weight and capacity. The new locomotives are of the 4-8-2 type, and the average weight carried per pair of coupled wheels is very nearly 38,000 lb. The tractive effort is 41,700 lb., which compares favorably with the motive power used on standard gage lines in the United States.

Locomotives of this general design have been in service on the South African Railways for some time, working between the Witbank coal fields and Johannesburg, hauling trains of 1,400 tons over this 80-mile stretch of track, the maximum grades being 1 per cent. The locomotives are designed to traverse curves of 300 ft. radius.

The new Baldwin engines have straight top boilers, with wide fireboxes of the Belpaire type. The inside firebox plates are of copper, a material which has given excellent service results in this district, where the water used is of exceptionally poor quality. A fire-tube superheater is installed, and the steam temperatures are indicated by the permanent installation of an electric pyrometer.

The frames are of the plate type, which were shipped completely assembled with cross-ties, cylinder saddle, cylinders, guides and guide yoke. The pistons were in the cylinders, and the cross-heads in the guides. This type of subassembly makes for considerable convenience in the final erection.

The equipment of these locomotives includes American steam brakes on the coupled wheels, and automatic vacuum brakes on the tender, with train connections. The special equipment includes Hasler speed recorders and a power operated grate shaker. On the right hand side of this locomotive is located a combination steam and hydraulic reverse mechanism, connected directly to the reversing shaft of the locomotive. This mechanism consists of one steam cylinder and one water cylinder. The two cylinder pistons are connected to a common piston rod, which in turn is fastened to the reverse shaft arm. The water cylinder is simply a cylinder with passages from one end to the other, and is entirely filled with water. This cylinder acts as a locking device for the holding of the reverse shaft in a desired position. The steam cylinder is used for moving the reverse shaft and at the same time causing the water piston to move it. When the steam valve in the cab is closed, the steam ceases to function and the water cylinder, by having equal pressure on both sides of the piston holds the gear in the proper position.

General Data

Gage	3 ft. 6 in.
Service	Freight
Fuel	Coal
Tractive effort	41,700 lb.
Weight in working order	205,100 lb.
Weight on drivers	151,900 lb.
Weight on leading truck	27,200 lb.
Weight on trailing truck	26,000 lb.
Weight of engine and tender in working order	310,000 lb.
Wheel base, driving	13 ft. 6 in.
Wheel base, total	31 ft. 9½ in.
Wheel base, engine and tender	57 ft. 7⅜ in.

Ratios

Weight on drivers ÷ tractive effort	3.64

Cylinders

Kind	
Diameter and stroke	22½ in. by 26 in.

Valves

Kind	Piston
Diameter	11 in.

Wheels

Driving, diameter over tires	51 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	9 in. by 10½ in.
Driving journals, others, diameter and length	8½ in. by 10½ in.
Engine truck wheels, diameter	28½ in.
Engine truck, journals	5½ in. by 8½ in.
Trailing truck wheels, diameter	33 in.
Trailing truck, journals	5½ in. by 11 in.

Boiler

Style	Straight top
Working pressure	190 lb. per sq. in.
Outside diameter of first ring	69 in.
Firebox, length and width	88 in. by 65⅛ in.
Firebox plates, thickness	9/16 in.
Firebox, water space	3 in.
Tubes, number and outside diameter	139—2¼ in.
Flues, number, and outside diameter	24—5½ in.
Tubes and flues, length	20 ft., 1⅞ in.
Heating surface, tubes and flues	2,338 sq. ft.
Heating surface, firebox	158 sq. ft.
Heating surface, total	2,496 sq. ft.
Superheater, heating surface	532 sq. ft.
Equivalent heating surface*	3,294 sq. ft.
Grate area	39.9 sq. ft.

Tender

Weight	104,900 lb.
Wheels, diameter	33½ in.
Journals, diameter and length	5½ in. by 10⅛ in.
Water capacity	5,100 gal.
Coal capacity	8 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

GOVERNMENT TESTS OF WATER-INDICATING DEVICES

Tests Demonstrate Unreliability of Many Water Indicating Appliances on Modern Locomotives *

THE development of the locomotive has created new difficulties in design, construction, maintenance and operation. One of the perplexing problems which has presented itself is that of securing a correct indication of the height of water over the crown sheet under all conditions of service.

The grave importance of this matter is evidenced by the number of crown sheets damaged, due to low water, where careful investigation fails to disclose any contributory cause.

In the locomotive boiler, which usually has a sloping back head and is generally equipped with arch tubes and brick arch, the heat is severely impinged on the door sheet and back end of crown sheet, creating severe agitation and rapid circulation up the back head and through the arch tubes. The water glasses and gage cocks, as generally applied, only indicate a corresponding level of water while the locomotive is at rest and with no steam escaping. When the safety valves lift or with the throttle valve open and the locomotive in operation, the gage cocks, when applied directly in the boiler, indicate a higher level of water than do the water glasses when they are properly applied and maintained. This discrepancy between the registrations of these devices has heretofore, been taken as a matter of natural consequence, and little consideration given to the cause or the result of the conflicting registrations.

Practically all enginemen and others having to do with the operation of the locomotive, true to a common understanding, believe that the correct height of water over the crown sheet is always indicated by the gage cocks, and that the level indicated by the water glass is unreliable and not to be depended upon; therefore it is reasonable to believe that enginemen have frequently depended upon a level of water indicated by the gage cocks as being correct, when in fact the true level was much lower, and, as a consequence, damaged crown sheets have resulted.

Realizing that this variation creates an unsafe condition and that its cause should be determined and a remedy applied, experiments have been made with different devices, on a number of locomotives of different classes, on fourteen railroads in various sections of the country, for the purpose of determining the action of the water in the boiler and its effect upon the gage cocks and water glasses.

Excerpts from tests made on five railroads on which the most extensive tests were conducted will serve to briefly describe the surprising conditions disclosed. During all of these tests and observations, representatives of the Bureau of Locomotive Inspection were accompanied and ably assisted by representatives from the mechanical department of the various railroads.

Summary of Tests

The locomotives on which the first series of tests was made were of the 2-8-8-2 mallet compound type, used in bad-water districts, equipped with boilers of the crown bar type, with wide fireboxes and Schmidt superheaters, and used oil for fuel. The devices for indicating the water level consisted of three gage cocks spaced 3 inches apart and applied directly in the back head near the knuckle, at right angles to the sloping sheet, and one water glass with bottom connection entering the back head approximately 3 inches below the back end of the crown sheet, and the top connection entering the back head 2 inches below the knuckle. The lowest reading of the water glass and gage cocks was 3⅝ in. above the highest part of the crown sheet.

The back heads of these boilers were braced by a "T" iron, extending crosswise, at approximately the same level as the back end of the crown sheet.

In order to determine the action of the water as indicated by these appliances, observations were made during five trips in freight service, covering a distance of 680 miles, under varying operating conditions and on varying gradients.

With the locomotive on straight track and no indication of foaming, water would issue from the top gage cock when it was opened, both while standing and in operation, while the safety valves were open or the throttle valve open, regardless of the water level in the boiler as registered by the water glass.

At the completion of the fifth trip, three additional gage cocks were applied in the back head, parallel with the horizontal center line of the boiler, the top one entering the back head 10½ in. below the top knuckle and 10½ in. to the right of the vertical center line, with the same vertical reading as the standard application, and will hereafter be known as "experimental gage cocks." These were applied for the purpose of determining the effect of changing their location toward the vertical center line of the back head and away from the knuckle, where the upward circulation of the water was believed to be greater than near the center.

An experimental water glass was also applied on the left side of the boiler, opposite the back flue sheet, the top connection of which entered the wrapper sheet on the top center line, 15 in. back from the throttle dome, while the bottom connection entered the wrapper sheet on the side. The lowest reading of this glass was 1 inch above the highest part of the crown sheet. This glass will hereafter be known as the "experimental water glass."

With this arrangement, observations were made during five additional trips, when the same conditions were found to exist that had been noted in the previous tests, with respect to the original gage cocks, namely, full water showed at the top gage cock, regardless of the level indicated by the water glasses, while the experimental gage cocks indicated a level approaching that indicated by the water glasses while operating with open throttle or safety valves blowing.

While operating with throttle wide open and water glass three-fourths full, the bottom connections to both water glasses were frequently closed and drain valves opened, when dry steam would steadily flow through the experimental water glass and solid water would flow through the original water glass, which glass also showed the water in severe agitation while the locomotive was in operation. These experiments demonstrated that the level of water indicated by the gage cocks and water glasses varied with their point of connection with the boiler, and indicated that a higher level of water prevailed at the back head than existed further ahead.

It is believed that the transverse "T" iron, which was applied to the back heads of these boilers, hindered the movement of water up the back head near the center, and consequently decreased the variation between the level of water indicated by the experimental gage cocks and that registered by the water glass.

As a result of these experiments, which were brought about

*This account tests recently conducted by the Bureau of Locomotive Inspection was prepared by A. G. Pack, chief inspector, through whose courtesy the article is published.

by the large number of crown sheets being damaged and fusible plugs being melted, the gage cocks and water glasses were moved toward the vertical center line of the boiler, which seems to have relieved the situation to a considerable extent.

Second Series of Tests

It having been concluded that the false registration of the gage cocks, when screwed directly in the boiler back head, and the agitation of the water in the water glass when top connection is made near the knuckle, were due to the rapid circulation of the water upward, carrying it a considerable distance above the level further ahead, a number of locomotives of the following description were equipped with water columns, as shown by Fig. 1:

These locomotives were of the Santa Fe or 2-10-2 type, equipped with Schmidt superheaters, Street stokers, used bituminous coal for fuel, carried 180 pounds steam pressure, with firebox 132 inches long and 96 inches wide, with brick arch supported by four arch tubes and back head sloping 15° from vertical.

The water column applied on these boilers, as illustrated by Fig. 1, was 1¾ in. inside diameter and 16 in. long, applied in a vertical position on the back head, 18 in. to the right of the vertical center line. The top connection was made by means of an angle valve with extension handle, extending through the top of cab, and copper pipe 1-1/16 in. inside diameter, entering the wrapper sheet 12½ in. in front of the back head knuckle and 14½ in. to the right of the top center line. The bottom connection was made of copper pipe 1-1/16 in. inside diameter, and entered the back head, through a three-way cock, 16 in. to the right of the vertical center line and 28 in. below the back end of the crown sheet. Three standard gage cocks with ⅜ inch openings were attached to the right side of this column, three inches apart. One water glass was also attached, with standard fittings, having ¼ inch opening. The lowest reading of both water glass and gage cocks was 4½ in. above the highest part of the crown sheet.

By this arrangement, it was believed that when entering the boiler far enough ahead of the back knuckle to obtain dry steam at all times through the top connection to the column, and by taking water from well below the crown sheet and below the agitated portion of water, a more correct reading could be obtained than when the gage cocks were screwed directly to the boiler head. During the approximate six-month period that these locomotives were operated with this arrangement, however, very considerable trouble was encountered, due to the extremely erratic and unreliable water indications.

When the matter was brought to the attention of the Bureau of Locomotive Inspection it was determined that something should be done to learn just what caused the trouble. Therefore, one round trip was made, covering 240 miles, where observations were taken under actual operating conditions, with the following general conditions noted:

At first start there was 3½ inches of water in the glass, reverse lever in full forward motion, with engine working up to the slipping point and working considerable water through the cylinders for about two miles. When locomotive was started the water in the glass receded very rapidly until it disappeared. The left injector was started and by opening any of the gage cocks, which had openings ⅜ inch in diameter, after the water had disappeared, dry steam was emitted for a few seconds, when the water in glass and column would rise to the cock that was opened and would be maintained unsteadily at the same level until the gage cock was closed, when the water in the glass would instantly recede slightly below this cock, which would be two to five inches higher than the level indicated before the gage cock was opened. From this point the water would gradually recede, taking four or five minutes to drop to the low point, and, when reached, the water would work normally in the glass, but would gradually recede to different levels and sometimes out of sight, depending upon the temperature of the water in the lower connection to the column.

This test was made many times during the trip and in all cases practically the same results were obtained. When the drain cock to the water glass was opened, the water in the glass and column would be raised as a result, and, when closed, the same receding conditions prevailed as when the experiments were made with the gage cocks, but would again settle to an indefinite point, sometimes out of sight, depending upon the temperature of the lower column connection. The gage cock was frequently opened slightly, so as to create a slight circulation through the column, which kept the temperature in the column and connection approximately that in the boiler, during which time the column glass and gage cocks appeared to register correctly.

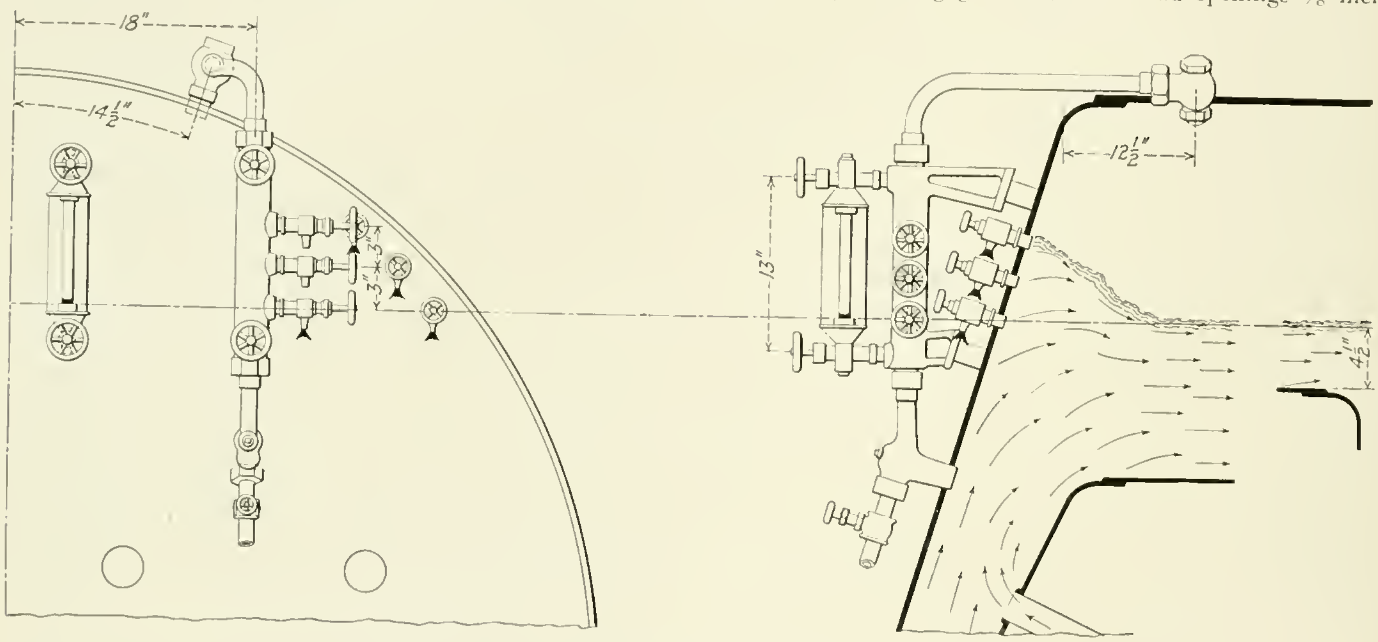


Fig. 1—Water Indicating Devices Used in Preliminary Tests

Numerous other observations were made, which gave results similar to those outlined above. During these tests the temperature of the atmosphere was below zero, which caused the water in the column and in the long pipe by which the bottom connection was made to cool rapidly, which in turn caused the level of water in the column to lower. In order to demonstrate that this reduction in temperature was the cause of the receding action in the column, ice water was poured on the bottom of the column. This caused the water in the column to lower very quickly while being cooled, and it would rise as soon as circulation was again established in the column.

It was demonstrated by experiments that this lowering of water in the column was due to the volume of dead water contained in the long pipe through which the bottom connection to the column was made. This was evidently due to the density and weight of the water at different temperatures, the temperature being much lower than that of the water in the boiler, due to the pipe and column being exposed to the cold atmosphere without circulation.

After noting these results and for the purpose of comparison, another water glass and set of three gage cocks were applied in the usual manner, as illustrated by Fig. 1, the water glass connections entered the back head at the left of column and the gage cocks entered near the knuckle. The comparative readings of all gage cocks and water glasses corresponded. For reference purposes the gage cocks and water glass applied to the column will be referred to as No. 1, while those applied in the usual way will be referred to as No. 2.

With the indicating devices arranged as outlined, observations were made during three successive trips, or 720 miles, when the following general results were noted:

Previous to starting, all devices indicated a corresponding level, but, when the throttle was opened or safety valves lifted, the water in No. 1 glass would recede approximately 2 in., while that in No. 2 glass would rise. No. 2 glass indicated a level of water from 1 in. to 3 in. higher than that indicated by No. 1 glass. In some cases, however, the water was out of sight at the bottom of No. 1 glass, while No. 2 glass indicated a level of from 3 in. to 5 in.

After noting these results, the following change was made: The bottom connection to the water column was raised 28 in. and moved to the right 2½ in. The new connection was made *midway between the two right arch tubes* and approximately 10 inches above them, about in line with the back end of the crown sheet. The object of this change was to move the bottom connection up as close to the lower end of the column as possible, and to reduce the volume of dead water in this connection in order to eliminate the lowering effect referred to. After this change had been made, the following general results were obtained: When starting, the level in both water glasses rose slightly and both glasses worked normally; and when the throttle was closed the level would recede slightly, the readings of both glasses corresponding under all conditions of service.

A comparison of the No. 1 gage cocks with the No. 2 water glass showed that they registered the same level when the gage cocks were opened moderately, or a sufficient amount to obtain a correct reading, but by opening the No. 1 gage cocks an excessive amount, or wide open, the water in the column and attached glass would rise from the bottom to the level of the cock opened. When the gage cock was closed, the water would instantly recede to its original working level and correspond with that shown in No. 2 glass. The receding action, as noted in the previous tests and before the bottom connection was raised, was entirely absent and the water registered a corresponding level in both No. 1 and No. 2 glasses under all conditions of service.

Tests of the No. 2 gage cocks, located as they were near the knuckle of the back head, proved that they were wholly unreliable for the purpose of registering the correct level of the water in the boiler while the locomotive was working, as they showed full water at all times, throughout the entire test, regardless of the level indicated by the water glasses and No. 1 gage cocks while steam was being rapidly discharged from the boiler, due, without question, to the rise of water up the back head. While standing, and with no steam escaping, the readings of both water glasses and all gage cocks registered alike.

Further observations and tests were made while on heavy grades, but no unusual or improper conditions could be noted except that No. 2 gage cocks registered full at all times, as previously stated, and the water in the column glass could be raised to the height of the gage cock opened, when opened excessively.

The opening in the bottom connection to the water column was then reduced to ¾-in. and observations continued. It was thought that by restricting the inlet at the bottom of the column it would prevent the water from rising in the column and attached glass when the gage cocks were opened excessively. The opening in the gage cocks was also reduced from ⅜ in. to ¼ in. inside diameter, so as to disturb the equilibrium of the water in the column as little as possible.

On this trip particular attention was given to the action of the water, as registered by the water glasses and No. 1 gage cocks by comparison, and it was particularly noted that the level of the water corresponded at all times under the varying conditions of service, while the standard gage cocks registered full water at all times with a high evaporation taking place.

As previously stated, in the original arrangement the top connection to the column was fitted with an inaccessible valve, the handle of which extended through the roof of the cab, thus making it difficult to tell whether or not the valve was open and the column in communication with the boiler at the top. In order to eliminate the possibility of these valves being left closed through carelessness, as is often done with water glass cocks, they were removed. The necessity for removing these valves was demonstrated by the serious damage to a crown sheet, by overheating, while the water showed in the water glass and the column gage cocks, due to one of these valves having been left closed on one occasion, while the locomotive was being prepared for service.

Third Series of Tests

The locomotives on which these tests were made were U. S. Railroad Administration standardized heavily Mallet 2-8-8-2 B type, with boiler and firebox of the following dimensions:

Boiler, type	Straight top
Boiler, pressure	240 lb.
Firebox, length	170⅛ in.
Firebox, length of grate	143⅝ in.
Firebox width	96¼ in.
Combustion chamber, length	37 in.
Heating surface, tubes and flues	5,685 sq. ft.
Heating surface, firebox	386 sq. ft.
Heating surface, arch tubes	49 sq. ft.
Heating surface (total)	6,120 sq. ft.
Grate area	96 sq. ft.

The crown sheet was 15 ft. 7 in. in length, with firebox equipped with Gaines furnace, and brick arch extending to within 68 in. of the door sheet and within 22½ in. of the crown sheet, supported by five 3½-in. arch tubes, using bituminous coal for fuel and fired with Duplex stoker. The boiler was equipped with one water column to which three gage cocks and one water glass were attached. Two gage cocks were applied directly in the back head and two water glasses applied in the usual manner, one on each side of the vertical center line of the back head as illustrated by Fig. 2.

The lowest reading of the gage cocks attached to the water column, and all water glasses, was 8 in. above

the highest point of the crown sheet and 13⅛ in. below the top of boiler back head. The limited dry steam space at the back end of this boiler had a marked effect on the readings of these devices when connected in the back boiler head.

Numerous observations were made on a number of locomotives of the same type, for the purpose of comparing the action of the water in the gage cocks and water glasses as originally applied and after certain changes were made. For the sake of brevity, however, the tests made on only one of these locomotives will be described, inasmuch as the results obtained were the same in all cases.

For the purpose of comparison, each of the connections was fitted with a valve, and extension handle, so they could be easily opened and closed, allowing changes from one to the other at will. The top connection to the right water glass was changed from its original location, which corresponded to that shown for the left one, to the location shown at B1 on the highest part of back head knuckle.

It will be readily understood that when water, from any cause, reaches the top connection, it destroys the proper registrations of these devices, and the idea in mind, when arranging the top connections in the manner illustrated, was to determine whether or not the reading of the water glasses and water column would be altered when changing from one connection to the other, which were in line with the upward flow of water between the door sheet and the back head, the object being to obtain dry steam to balance the volume of water in the water glasses and water column. The result of changing from one connection to the other was indeed surprising.

A1—*Water column connection where it entered boiler on back head knuckle ½ in. higher than top gage cock and 6⅝ in. below highest part of back head as originally applied.*

A2—*Water column connection where it entered boiler at highest point of back head knuckle.*

A3—*Water column connection where it entered boiler on top center line in front of back head.*

B.—*Right water glass.*

B1—*Right water glass connection where it entered boiler in back head knuckle.*

B2—*Right water glass connection where it entered boiler in front of back head.*

C.—*Left water glass.*

C1—*Left water glass connection where it entered back head knuckle 4½ in. below highest point of back head, measured vertically and 2⅛ in. above top water glass reading, as originally applied.*

C2—*Left water glass connection where it entered boiler in front of back head.*

With the locomotive working heavy throttle, column A and glass Ax, connected at A1, the original connection, would be completely filled, while glass B, connected at B1, indicated 1 inch of water. By changing the connection A1 to A2, the water would instantly recede to a level in A and Ax corresponding with that indicated by glass B, or 1 inch, when A, Ax and B would continue to correspond while connected at A2 and B1, until the reading approached 4½ to 5 in., at which point the water would become erratic and soon fill column A and glasses Ax and B if the injector was slightly over-supplying the boiler, or would recede and correspond if the water was slightly lowering in the

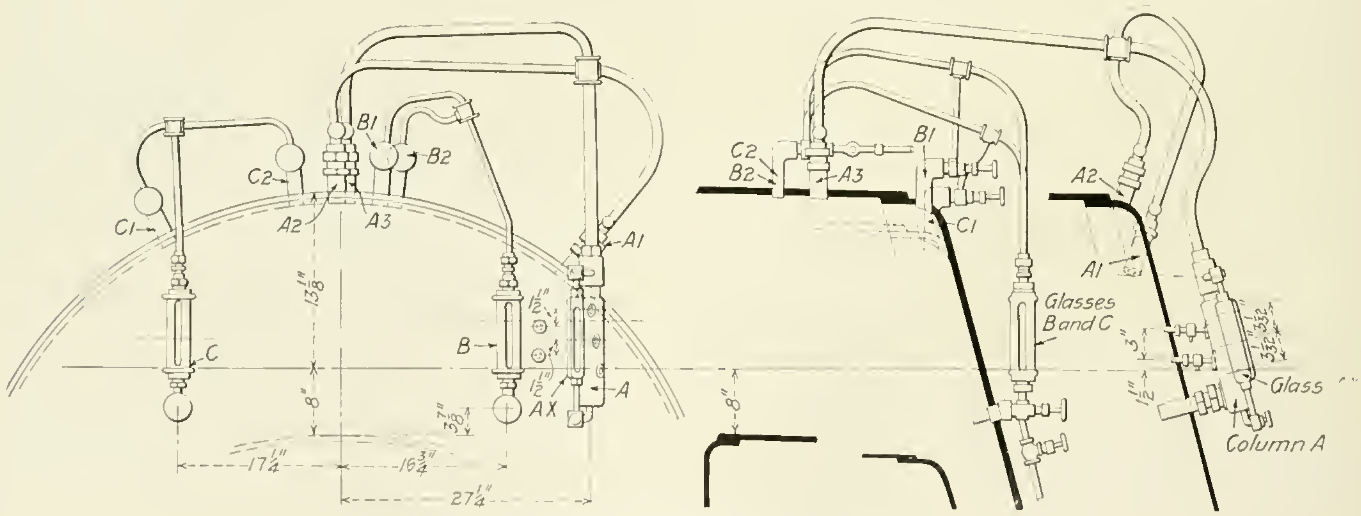


Fig. 2—Water Indicating Devices Used in Third Series of Tests

With the locomotive equipped with water glasses and gage cocks, as shown by Fig. 2, it was used in pusher service, on an ascending grade of 61 feet per mile, during five successive trips, occupying a period of time aggregating four hours and twenty-five minutes.

While the locomotive was standing, with no steam escaping, the registration of all devices showed a corresponding level of water. A total of 121 readings were taken and recorded while on straight track and while the locomotive was working with heavy throttle with about the same firebox temperature and steam pressure.

For reference purposes, the water glasses and water column, with their connections, are referred to by letters and figures as follows:

A.—*Water column to which three standard gage cocks were applied.*

Ax—*Water glass applied to water column.*

boiler. This indicated that the water was moving up the back head, with fountain effect, to a point reaching the connections A2 and B1 where they entered the top knuckle of the back head, 8⅛ in. higher than they registered when connected at A3 and B2 on the wrapper sheet, and was illustrated by changing the connection to column A and glass B from A2 to A3, B1 to B2, when the water would instantly recede to its former reading, and the readings would then continue to correspond as long as the connections remained at A3 and B2, without regard to condition of service or height of water indicated.

These readings could be varied as often as desired, by shifting connections to the boiler by use of the valves; that is, when the column connection was changed from A3 to A2, the water would immediately go from 5 in. to out of sight in glass Ax, and top gage cock would show full water; or, when changed from A2 to A3 the water would

recede from out of sight to a level of 5 in. and correspond to the reading shown by glass B connected at B2. With glass B connected at B1, the reading would correspond with column A and glass Ax when connected at A3, until the level approached 5 in., when the water in glass B would become erratic and soon fill the glass, while column A and glass Ax, connected at A3, retained their level of 5 in.

These experiments illustrated that column A and glass Ax were incorrect when connected at A1, the original connection, with 1 inch or more of water; and, when connected at A2, were incorrect when the level indicated exceeded 4½ in. to 5 in.; and correct at all times when connected at A3; and that glass B was correct when connected at B1, until the reading indicated 4½ in. to 5 in., and incorrect when more water was shown, until connection was changed to B2.

With glass B registering 5 in. of water, the connection was changed from B2 to B1, when the glass would immediately fill; and with the bottom water glass cock closed and drain valve open, solid water flowed steadily through the drain pipe, which showed conclusively that the flow of water up the back head, with fountain effect, reached the connection B1 where it entered the back head knuckle 8⅛ in. higher than the correct level of water in the boiler or that registered by glass B when connected at B2, and by A and Ax when connected at A3.

With glass C in communication with the boiler at C1, its original connection, it registered a level corresponding to that indicated by column A, glass Ax when connected at A3, and with glass B when connected at B2, until the water registered 2½ in. to 3 in., at which time the water in glass C would become erratic, rising and lowering and rapidly filling, providing the injector was more than supplying the boiler, notwithstanding column A and glasses Ax and B, connected at A3 and B2, worked normally and indicated 2½ in. to 3 in. of water.

When glass C communication was changed from C1 to C2, the water would instantly recede from out of sight at top to a level of 2½ in. to 3 in. and give a corresponding reading with column A and glasses Ax and B, which was true at all times when all connections were made ahead of back knuckle, regardless of the condition of service or the level of water in the boiler.

The reading of glass C, when it indicated in. or more of water, could be changed as frequently as it was desired, by changing the communications from C1 to C2 or vice versa.

It was noted on one occasion, with column A connected at A1, glass B connected at B2 and glass C connected at C1, the locomotive moved to a left-hand curve, at which time water glass B registered 2 in. of water while column A and glasses Ax and C were completely filled.

Sixteen readings were taken on the fourth trip, with column A connected at A1, the original connection, glass B at B2 and glass C at C1, original connection, during which time glass B indicated a level of from 1¼ in. to 4¾ in., while glasses Ax and C and all gage cocks in both column and back head showed full of water. In fact the gage cocks applied directly in the back head showed full of water at all times during these tests, while the locomotive was being operated or when the safety valves were open.

By referring to Fig. 2, it will be noted that connections to water glasses are made to the boiler through ell connections. In changing the street ells from their original location on the back head to the location shown at B2 and C2, the C2 connection was tapped so as to drain thoroughly, while B2 was leaned sufficiently to cause a trap to be formed. This trap caused the water in B glass to rise 2 in. to 3 in. higher than that registered by the left glass; and when this trap was removed, the water indication in all three glasses corresponded. This condition has been found in a number of the locomotives under investigation, when, as soon as the traps were removed, the discrepancies were obviated.

(*To be continued*)

FUEL STATIONS

At the 1915 convention several devices were reported for measuring the coal as delivered to locomotives, but at that time none of the suggested equipments had been extensively used. Since that date, however, there has been a considerable number of at least two of the suggested types of equipments installed and maintained regularly in service.

One of the earliest installations is that of the Nashville, Chattanooga & St. Louis at Cowan, Tennessee. These machines have been operating since 1916 with an average issue of 200 tons of coal per day and have handled up to a recent date approximately 192,000 tons. This railroad also has six additional equipments of the same type at three other points. At one of these stations the record for the past twenty months,

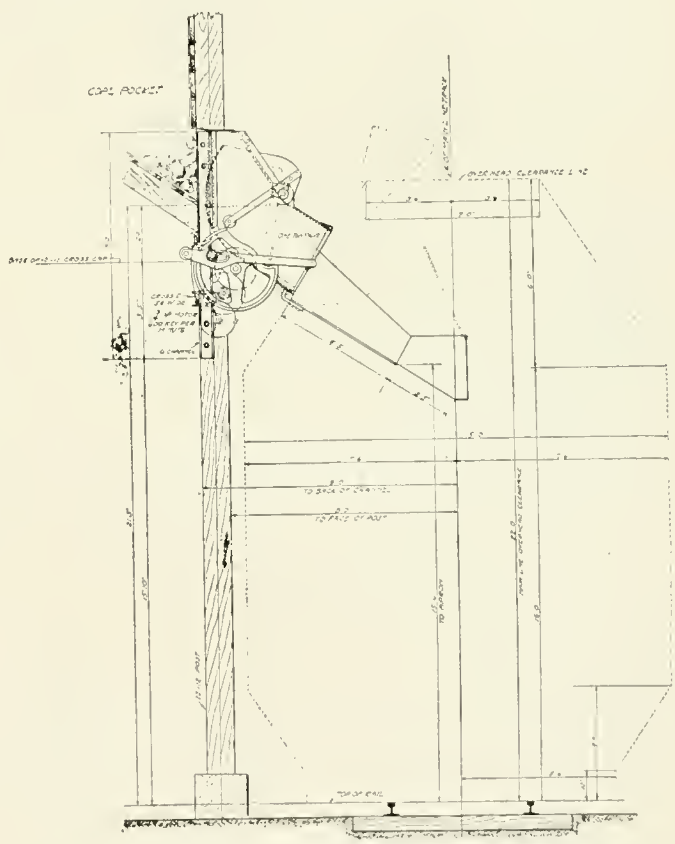


Fig. 1—Coal Measuring Device, N. C. & St. L.

with no break-down, indicates 150,000 tons of coal issued, one device recording 88,234 tons.

Fig. 1 outlines the general arrangement of this type of measuring device and illustrates its application to an existing chute. This machine is operated with a two-horsepower electric motor in one continuous rotary movement in one direction. It is so designed that as the delivery gate is opened, the undercut gate arm rolls on the surface of the large cam, in that way locking it. When the undercut gate is down, ready to receive the issue of coal from the bin, the delivery gate is also locked, and these movements alternate so that it is impossible to have both gates open at the same time and thus release a bin full of coal. The ordinary operation is five cycles per minute. As first constructed, the cut gears used

*From a report presented at the 1920 convention of the International Railway Fuel Association.

were made of cast iron. These broke in several instances, so that all steel gears are now used with the equipment.

There is one feature in connection with the use of such power driven machinery as this which should be mentioned, and that is, that it is a practical necessity to have the coal issued by the assigned operator at the coaling station. Such a mechanism should not be handled promiscuously by many different men, most of whom would know nothing beforehand of its construction or method of operation. This equipment, the same as other parts of mechanically operated coal chutes, requires regular and systematic attention and maintenance.

As illustrating the second type of measuring device, the Chicago, Milwaukee & St. Paul in 1918 installed the equipment shown in Fig. 2 on a 75-ton coal chute at Jackson, Minn. With this equipment the operator, after lowering the chute into position, discharges the coal from the measure by pulling on the operating rope. The locked-in position of the unbalanced measure is thus released and the entrained coal is discharged, the inlet gate being automatically closed. When the measured coal is all discharged, a second pull on the operating rope tilts the measure back

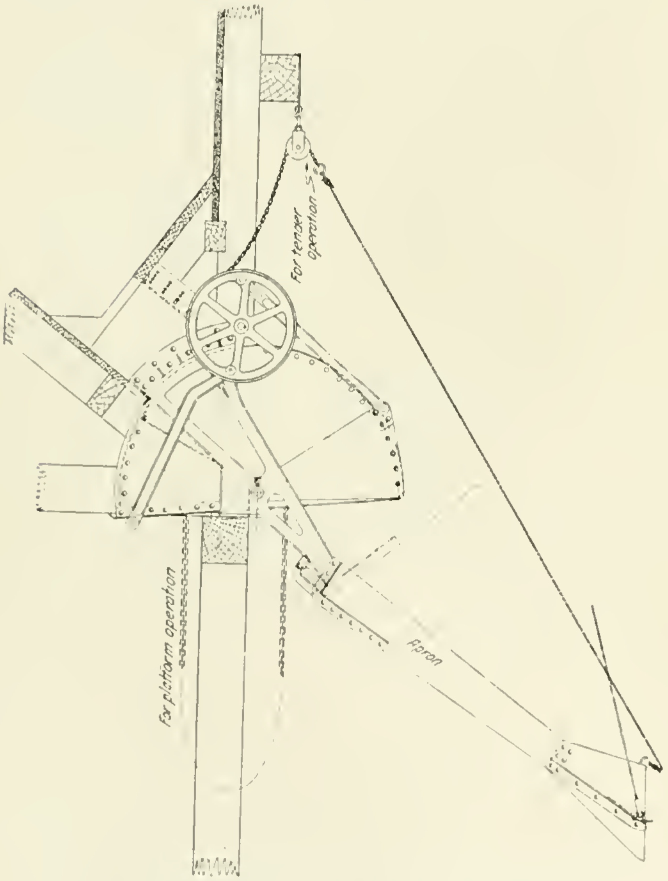


Fig. 2—Coal Measuring Device, Jackson, Minn., C. M. & St. P.

again to the filling position, closes the outlet gate and opens the inlet gate. As the measure is again filled the operations are repeated. The reported time for taking five measures or five tons of coal is three minutes, that is, from the instant that the engine stopped in front of the chute until it started away. There are 14 engines taking coal at this point, averaging 5.8 tons per engine. A recent report on this particular installation advises that, "There is no question in our minds, however, but that this device gives much closer approximation to correct weights than the old method of estimating weights. The device appears to be satisfactory to all concerned and it costs much less to install than scales."

Discussions and reports presented at the convention from year to year have called attention to the necessity of delivering the coal into the storage bin in such a manner that the fine and coarse coal will not segregate, with the resulting effect that one locomotive tender will receive all coarse lump coal and the next one get only the fine and in some cases almost powdered coal. The coal should fall on the pile in the bin at a point directly over the discharge opening. The natural separation of the coarse coal toward the lower edge of the pile will not then materially affect a fairly uniform mixture of the coarse and fine coal at the point of discharge. Fig. 3 illustrates the arrangement which caused the trouble. The bucket conveyor delivered the coal over the idler at the

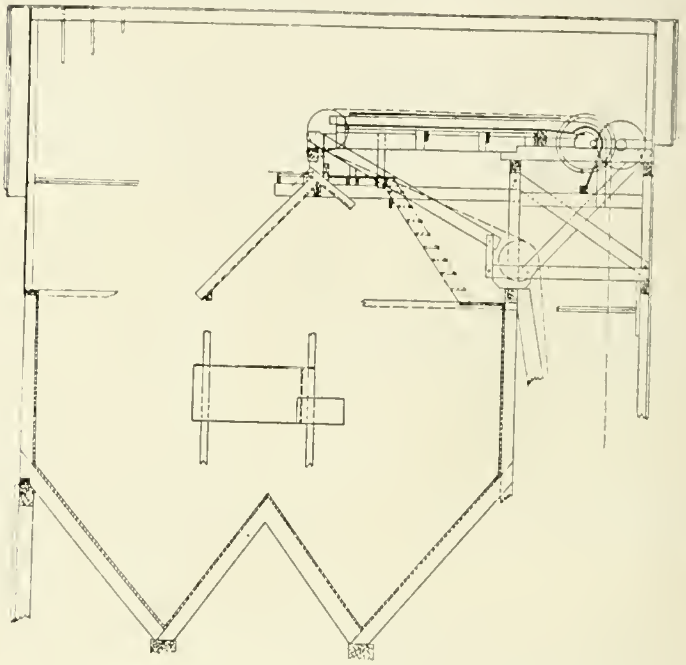


Fig. 3—Improper Discharge of Coal to Storage Bins

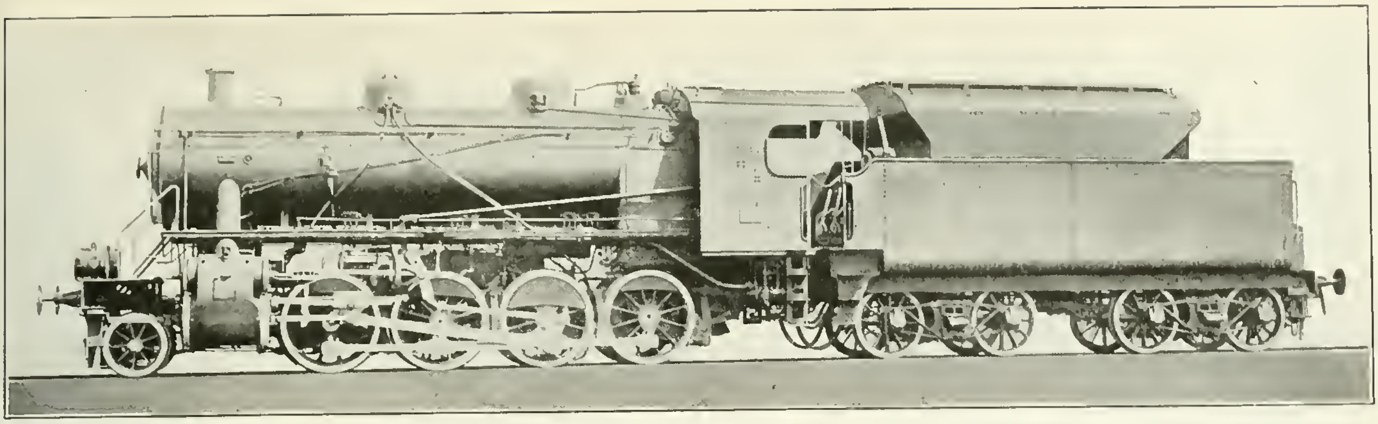
center of the bin. The coal then dropped to the upper ends of the two inclines shown, but in passing over the edge of the conveyor, practically all the lumps threw over onto the long incline and only fine coal dropped onto the short incline. Further, the momentum of the coal on the long incline was such that the coarse coal was all delivered on the pile against the left hand wall of the bin and as the bin was filled full only fine coal worked over the center ridge to the right hand discharge opening. By eliminating the inclines and providing a discharge opening in the conveyor directly over the center of the right half of the bin, coal is being delivered to each of the two tracks well and uniformly mixed.

Another railway reports satisfactory improvement in the mixing of the coarse and fine coal by the use of a baffle at the lower end of the distributing chutes. The purpose is to deflect the lumps downward so that they will fall vertically with the slack instead of falling over to one side of the pocket and there forming a mass of lump coal. However, this does not, as arranged, apparently entirely eliminate the separation trouble.

[The report included a number of illustrations of typical fuel oil stations, which were presented without critical comment.—Editor.]

The report was signed by W. E. Dunham (Chairman), C. & N. W.; E. E. Barrett, J. C. Flanagan, J. W. Hardy, W. T. Krausch, R. A. Ogle, J. L. Ripley, C. F. Luddington, C. M. & St. P., and J. E. Nellegar.

Oil Burning Engine Explodes.—A yard engine used for shifting cars in the Mt. Clare yards of the Baltimore & Ohio recently exploded, injuring seven men. While the cause of the accident has not been determined, it is believed that one of the feeds became clogged, allowing the oil to back up and generating considerable gas.



Italian Locomotive Equipped for Burning Pulverized Coal

Pulverized Coal Burning Equipment for Europe

Description of Locomotives Recently Designed to Utilize Low Grade Coals in Italy and Holland

FROM an economic standpoint the war has affected nothing more radically than the relation of supply and demand for fuel. This basic commodity, which has always been more costly abroad than in the United States, has now become fabulously expensive in those countries in Europe that are forced to import coal. Italy and Holland are in this class, although there is a native supply of very inferior coal in both countries. The desirability of utilizing this native fuel is accentuated by the fact that each of the European countries, as a result of the lessons taught by the great conflict, is more anxious than ever to become independent of outside sources for its basic commodities. This applies particularly to coal, and for matters of diplomatic policy alone, both Italy and Holland find ample incentive for undertaking expenditures for special equipment that would enable them to utilize the coal available within their borders. In this connection it was thought that pulverizing as a means for utilizing native low grade coals was worthy of a trial and the results will be watched with unusual interest in the United States, where enormous deposits of lignite coal are lying untouched. Barring consideration of any higher efficiencies that may obtain with the consumption of fuel in a pulverized form, the fact that it may render available relatively inexpensive fuels that can now be mined directly tributary to many railroads warrants the most serious consideration in a country where there will probably never be any necessity to import basic commodities.

It is highly complimentary to American manufacturing enterprise that after making a thorough investigation of the field, the engineers from both the Italian and the Netherland State Railways selected coal pulverizing and pulverized coal burning equipment developed and manufactured by the Fuller Engineering Company of Allentown, Pa.

Lignite Coal Available in Italy

The Italian State Railways have had to depend entirely on imported coal for locomotive fuel, which is now costing them about $34 a ton in United States currency. The native coal in Italy is a very low grade fuel and unsuitable for hand-fired locomotives. It is largely in the form of lignite and this has led the State Railways to equip two of their new heavy Consolidation type locomotives for burning pulverized coal, as it is thought that this grade coal can be burned in a pulverized form.

There are a great number of lignite coal mines in Italy, the largest of which has an annual output of nearly 1,000,000 tons. These mines are located in several different parts of the country and the coal from various localities exhibits a wide range in composition. The following analyses may be taken as representative:

Moisture (determined separately)	25.7	29.2	31.4	6.4	28.6
Volatile	31.1	47.8	46.9	2.4	32.3
Fixed carbon	20.8	36.3	40.8	66.1	58.5
Ash	48.1	15.9	12.4	31.5	9.2
B. t u. (dry basis)	4,918	8,977	9,072	9,337	11,606

The last of an order of 150 Consolidation type locomotives for the Italian State Railways was being completed in the shops of the American Locomotive Company at Schenectady, N. Y., when it was decided to apply pulverized coal burning equipment to two of these locomotives. The order was placed with the Fuller Engineering Company and was completed in less than 60 days from the date of order. The locomotives were tested out with pulverized coal (about 10 tons being consumed on the two locomotives), knocked down and shipped to Italy.

Description of Locomotives

The locomotives have the following specifications:

Cylinders	21¼ in. by 27½ in.
Steam pressure	170.6 lb. per sq. in.
Drivers, diameter	54 in.
Weight on drivers	131,500 lb.
Total weight	148,000 lb.
Grate area	34½ sq. ft.
Maximum tractive effort	33,400 lb.
Heating surface:	
Tubes	1,331 sq. ft.
Flues	485 sq. ft.
Firebox	117 sq. ft.
Superheater	407 sq. ft.
Water capacity	5,900 gal.
Fuel capacity	10 metric tons
Wheel base, engine and tender	55 ft. 3-1/16 in.

Practically the only change necessary in the tender was to substitute a U-shaped tank, move the tank bodily on the tender back toward the rear 7 inches in order to better distribute the weight on the front and rear trucks. Due to the compactness of the equipment it was possible to install it without in any way altering the water legs from the standard design of the other tenders, the only change in this respect being that the hand brake handle had to be raised somewhat to allow for clearance. As only one coal plant is to be provided in the initial installation it was of course necessary to provide for a much larger fuel capacity than on the hand fired locomotives, which is the reason for applying a tank holding 10 metric tons. A standard American type of brick arch supported on tubes is placed in this locomotive firebox and the sides of the combustion chamber beneath the firebox proper are bricked

up in a standard manner with air vents controlled by dampers, these all being controlled from the cab on the fireman's side.

Pulverized Coal Equipment

The coal is blown in suspension from the tender to the locomotive through 2 ft. 5 in. dia. flexible hose, and the coal feeder is controlled from the fireman's position in the cab by means of a flexible shaft, the ratio between the minimum and maximum coal feed of 346 per cent being obtained and this ratio is again doubled by throwing in or out either one of the two pairs of feed screws by means of the clutches, which project over the apron within easy reach. Four 4-in. dia. steel feed screws operating in pairs draw the coal from the bottom of the tank to the front of the feeder, where it is met by the air from a steam turbine driven fan and blown into the firebox. The feed screws are driven by a two-cylinder, double acting reciprocating engine, enabling the widest variation to be obtained with the minimum steam consumption at all times. A feature of this equipment is that the screws can be started up and operated on 25 pounds of steam pressure. This is a great advantage when it is considered that very often the pressure in roundhouse firing up lines drops to 30 pounds. Due to the screws being operated in pairs, it is impossible for the coal to arch over at any time and a steady constant feed is obtained at all times, no matter how heavy the coal or how long it has been in the tank.

At the same time the order was placed for the locomotives a pulverizing plant was also ordered from the Fuller Company to consist of two standard 42-in. screen type Fuller-Lehigh pulverizing mills having a capacity of approximately 4 tons per hour each, a standard drier, fired by pulverized coal and having an approximate capacity of 10 tons of dried coal per hour. The coal plant throughout is of the standard type with track hopper for receiving the coal from the cars, single roll crusher for crushing it down to the proper size for the pulverizing machines, magnetic separator for removing all tramp iron, etc., and all necessary conveyors, elevators, as well as 40-ton pulverized coal storage bin divided in half, which is placed over the track. Two separate butterfly valves with filling spouts are provided for coaling the locomotives. The plant is driven throughout with electric motors and is equipped with dust collectors, separators, etc., in order to make a clean, dustless, modern plant.

Fuel Situation in Holland

There has been an enormous increase in the cost of fuel imported by Holland for firing locomotives and in order to utilize the cheaper grades and culm piles which have accumulated during many years, the Netherland State Railways have decided to equip two express type passenger locomotives for burning pulverized coal as an initial experimental installation. After a thorough investigation of the subject in their own country and abroad an order was placed with the Fuller Engineering Company in January, 1920, for two complete locomotive equipments as well as a coal pulverizing plant for furnishing these locomotives with pulverized coal.

The coal which is now being hand fired has the following approximate analysis:

Moisture	20 per cent	Ash	7 per cent
Volatile	12 per cent	Sulphur	1 per cent
Fixed carbon	80 per cent		

B. t. u. value, 14,000.

The coal which it is desired to utilize in pulverized form has the following analysis:

Moisture	4 to 14 per cent	Ash	9 to 15 per cent
Volatile	9 to 24 per cent	Sulphur	1 per cent
Fixed carbon	52 to 74 per cent		

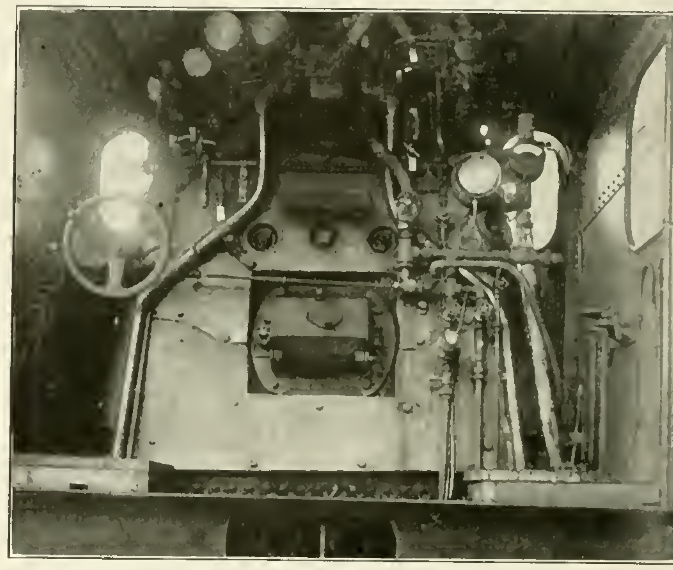
B. t. u. value of this coal, 11,000 to 13,000.

Locomotives which it has been decided to equip are of the ten-wheel type with four simple high pressure cylinders in the same plane, two outside of the frame and two inside. The specifications of the locomotive follow: Cylinders, 15¾-in. by 26 in.; steam pressure, 170 lb. per sq. in.; drivers, 73 in. dia.; weight on drivers, 96,000 lb.; total weight, 140,000 lb.; firebox, 110 7/16 in. by 39⅞ in.

A unique feature of this locomotive, and one which will make it particularly adaptable to pulverized coal, is that on account of having four high pressure cylinders there will be eight exhausts for each revolution of the drivers, which will of course produce a much more even draft through the tubes and firebox.

Description of Equipment

Equipments which will be installed are duplicates, with a few improvements and alterations, of the ones furnished to the Italian State Railways and are also very similar to the one which has been in use on a Lehigh Valley locomotive for the past year, burning mixtures of anthracite silt and bituminous coal with success. The coal plant will contain two 33-in screen type pulverizers, an indirect pulverized coal fired drier with all necessary motors, elevators, dust collectors, etc., to make a complete and modern plant in every detail.



Interior Cab, Italian State Railway Locomotive

The coal will be received direct into a track hopper from the car and will be crushed down to standard size for the pulverizing mills and delivered to a 20 ton storage tank for coaling the locomotives over a track adjacent to the pulverizing building. The operation will be continuous and entirely mechanical from the time the coal leaves the cars until it is placed in the storage tank over the track. The tank in which the pulverized coal is carried will hold 8 tons of pulverized coal, enabling a round trip to be made with only one fueling. No changes in the outside arrangement of the tender whatever are made, thus enabling the water to be taken as at the present time, at any place along either side of the tender, in the troughs provided, as this is standard practice on the Netherland Railroads. The locomotive will have a brick arch supported on lugs, as it is now standard practice in Holland.

Due to the difference in cost of the coals which they are now burning and which they intend to burn, it is calculated that the whole investment can be paid for in one year, due to the savings resulting therefrom, and it is the intention of the company working the Netherland State Railways to extend the application of pulverized coal burning equipment to other locomotives of suitable size and type as soon as the two which are now ordered have been in operation long enough to determine how much these savings amount to.

CAR DEPARTMENT

BETTER FOUNDATION BRAKE GEAR AND AUTOMATIC ADJUSTMENT NEEDED

BY W. H. SAUVAGE

The use of automatic slack adjusters on electric equipment is becoming general throughout the country. On steam railroads spasmodic attempts to use these devices have been made for several decades. Perfect regulation when made by hand is ideal, but human agency is not dependable. In order to obtain perfect adjustment of the brakes the first requisite is to have a satisfactory foundation brake gear. In recent years more attention has been paid to getting a stronger and less flexible gear than in the past; however, the roads have not departed from first principles in simplifying the foundation brake gear to any appreciable extent. It is true that the roads are gradually retiring outside hung brakes and generally adopting the more reliable inside hung brake, with the brake beam hangers so attached as to prevent their deflection on the wheels, whether cars are empty or loaded, so that more uniform piston travel and brake chain take-up becomes possible.

While this improvement has been in the right direction it should never stop there. Pullman and electric cars have all truck levers standing vertically along the center line of the truck, thus producing as nearly as possible 100 per cent efficiency. This, however, is not the case with freight car equipment or locomotive tender trucks; without any exceptions all car trucks still use truck levers set at an angle of 40 deg., which necessitates a right and left brake beam for every truck. A few years ago a more simple, compact, and reliable brake gear with all truck levers vertical was introduced. This arrangement does not require right and left brake beams, making every beam interchangeable, or by using a reversible strut it allows the use of levers set at a 40-deg. angle when so desired.

This simplified foundation brake gear does away with four clevises, two lever fulcrums and two extra floating levers which are required at the present time to get the reverse pull on the truck levers on opposite ends of the car. The cylinder levers remain of equal dimensions as before, the pull rods are attached thereto in the center line of the car to the truck levers direct; in this manner they do not interfere with hopper bottom arrangements. Providing this direct connection, thus eliminating the extra floating levers and guides, reduces friction to a minimum, making both the power and hand brakes more efficient than under the old arrangement. Brakes release more promptly, preventing unnecessary brake shoe drag, which reduces the tractive effort of a locomotive often as much as 20 per cent.

When brakes with a modern gear require adjustment, conditions will immediately be improved, whether made manually or automatically. Manually adjusted brakes we are all quite familiar with, but we are not yet fully convinced of the advantages of automatic adjustment. Many automatic devices for adjusting brakes have been brought out from time to time during the last 25 years and some have shown a great deal of merit. Simplicity is the first requirement for an automatic device, next reliability, while durability is essential, especially for freight car equipment.

Let us analyze what it means to have ideal adjustment of brakes on freight cars. Dragging brakes consume a great deal of energy, limiting the hauling power of the locomotive, consuming more or less unnecessary fuel, delaying movements of trains from point to point and causing improper air brake performance. This is primarily due to brakes being adjusted too tight against the wheels. Frequently cars have long piston travel and yet the brakes are found dragging. This is not always entirely due to improper foundation brake gear, but more often arises from the methods employed by the man who adjusts the brakes. In any freight yard when the inspector finds a car with long piston travel he takes advantage of shortening this travel under the end of a car which seems to require the least labor to take up the slack. As a rule he does not go to the trouble to take up or let out the false piston travel on the truck that needs it most, but gets under the easiest end and pulls up the dead lever as far as it will go, and usually manages to get the travel within a few inches of what he wanted it to be. If it is a little long or a little short doesn't matter, to obtain the exact piston travel he desires would require considerable time, so he lets it alone. What the inspector should have done was to balance up the levers on each truck and not allow the shoes on one brake beam to stand away several inches off the wheel on one truck, with the shoes tight against the wheels on the other truck. To do this properly it would probably be necessary to take up slack on the bottom rod connection, but that means more work, and he follows along the lines of least resistance, which is human nature. To get absolutely perfect adjustment is a slow process. The time required to properly adjust brakes on a 100-car train to some predetermined piston travel is often serious and leads to expensive delays aside from the labor involved.

What does it mean to have a train of cars running over

the road or in classification or hump yards with imperfectly adjusted brakes? In the first place the brake gear is the fundamental foundation upon which rests all the good or evil results to be obtained by the use of the air brake. The air brake mechanism is only the governable power appliance attached to the foundation brake gear. Without a reliable foundation brake gear the brake cylinders and triple valves are inefficient. In order to get a perfect air or hand brake control it is necessary to commence at the foundation brake gear; with that in first-class condition the air brake and hand brake mechanism can produce the results they are intended for—to stop or control a train under all circumstances. It would seem almost a criminal expense to operate any power or hand brake with improper adjustment. With the present unsettled labor conditions the improvement so much needed in order to obtain better brake regulation by manual labor seems to be more remote than ever before.

Damage to cars and lading, one of the greatest of all losses in the operation of railroads, can by concerted efforts be gradually eliminated by introducing automatic devices for regulation of the brakes.

It is needless to enter into details of the vast amount of property and injury losses occurring every day, both to trains running over the road and cars switched around terminals and yards. Recently an officer of one of the large eastern railroads reported that in the first week in April, 1915, the lading damage alone on his road ran into five figures, and during the first week in April, 1920, it increased to 29 times the amount in 1915. The damage to property outside of lading is another matter for which some staggering figures could be shown no doubt. Probably poor brakes have a great deal to do with it. Much damage to lading occurs in classification and hump yards. Improperly adjusted brakes permit long brake chains, which also mean long piston travel, producing a bad acting air brake and at the same time an unreliable hand brake, their efficiency having been reduced in this manner in many cases as much as 75 per cent, so that the men who are riding these cars are unable to control them with the braking power on a loaded car often as low as eight per cent. Cars with bad brakes go down the hump striking cars standing still at high speed, which causes most of the damage which occurs both to rolling stock and lading, due to improperly adjusted brakes.

When the trains are running over the road with all kinds of piston travel and all kinds of lading these conditions will invariably produce shocks often as great and more destructive than those done by single cars bumping into each other in hump yards. That this is the truth cannot very well be disputed, so that the only way to remedy this defect is to insure uniform predetermined piston travel, allowing every brake cylinder to do the same work in the same time, both in applying and releasing. Short travel develops high pressure quickly and long travel low pressure very slowly, and here is where the evil arises. There never can be more than one safe remedy to overcome this property and damage loss—that is to insure that very brake cylinder piston travel be automatically regulated to one common standard.

We have relied for 50 years on human agency. Has not the time now arrived when it would be advisable to begin the employment of an automatic device and see if this most vital problem cannot be better solved in this manner?

What a Locomotive Costs Each Day.—According to a computation made by the Emerson engineering organization, each railroad locomotive in the United States costs $84.31 a day more to operate than the revenue it yields in return. In the Eastern section, according to this computation, the daily operating cost averages $296.63, and the revenue $206.57. In the South the operating figure averages $292.82, and the revenue $208.60.—*Erie Railroad Magazine.*

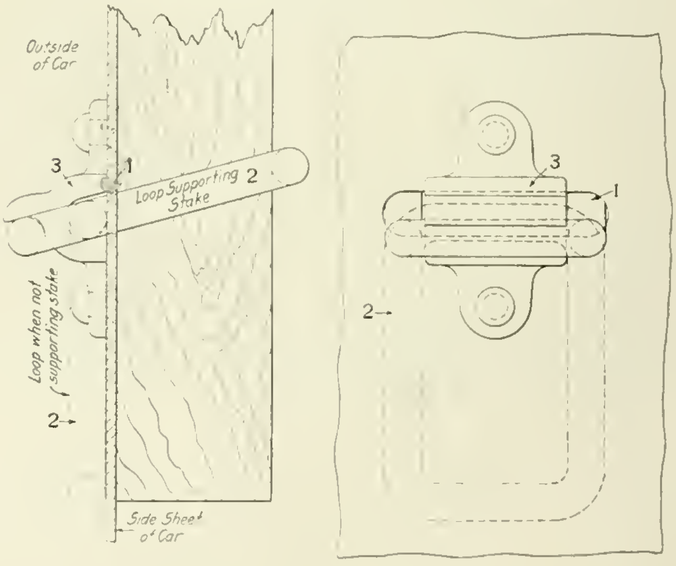
DROP LOOPS TO SUPPORT STAKES INSIDE GONDOLA CARS

BY W. J. KNOX
Mechanical Engineer, Buffalo, Rochester & Pittsburgh

Railroad gondola cars are used principally for the transportation of coarse and bulky freight, such as pig iron, steel billets, lumber, pipe, structural work, etc. When loaded with lumber, pipe, poles and similar materials, which extend above the top of the sides and ends, it is necessary to provide temporary stakes, and this type of car is equipped with permanent stake pockets at either the outside or inside face of the side walls.

For cars with wooden sides the construction usually permits application of the pockets to the outside, while for steel sides the pockets are at the inside of the car. Placing the usual rigid stake pockets at the inside has been found undesirable because they are bent and broken and rendered useless by ladings of billets, pig iron and other heavy and bulky commodities and shifting loads.

To overcome this trouble a number of so-called collapsible stake pockets have been designed. These are supported at



Drop Loop Stake Supporter

the inside of the car by some form of hinge, and when dropped and out of use the projection from the side wall is decreased and to some extent the hazard of damage is lessened, but by no means prevented. By the arrangement represented by the drawing, when the drop stake pocket is not in use supporting a stake at the inside of the car, it hangs suspended at the outside without projection of any kind at the inside, and therefore cannot be damaged by the lading.

Referring to the illustration, at a position where it is desired to locate a stake, a slot *1*, a little larger than the over-all width and thickness of the loop *2*, is cut through the side sheet of the car, and over this, with the loop in place, is riveted the supporting bracket *3*. The full lines indicate the position the loop occupies and how it is carried by the bracket when employed to support a stake. When the stake is removed the loop is slid through the slot to the outside of the car and hangs suspended from the bracket in the position shown by dotted lines.

Non-Coking Coals.—Experiments conducted at the University of Illinois on low temperature carbonizing of coal indicate that the so-called non-coking coals of Illinois may be advanced one of these days into the class of coking coals. Working at 750 deg. C., the gas produced was high in calorific value; the tars were of unusual interest.—*Scientific American.*

The Beahm Automatic Train Pipe Connector

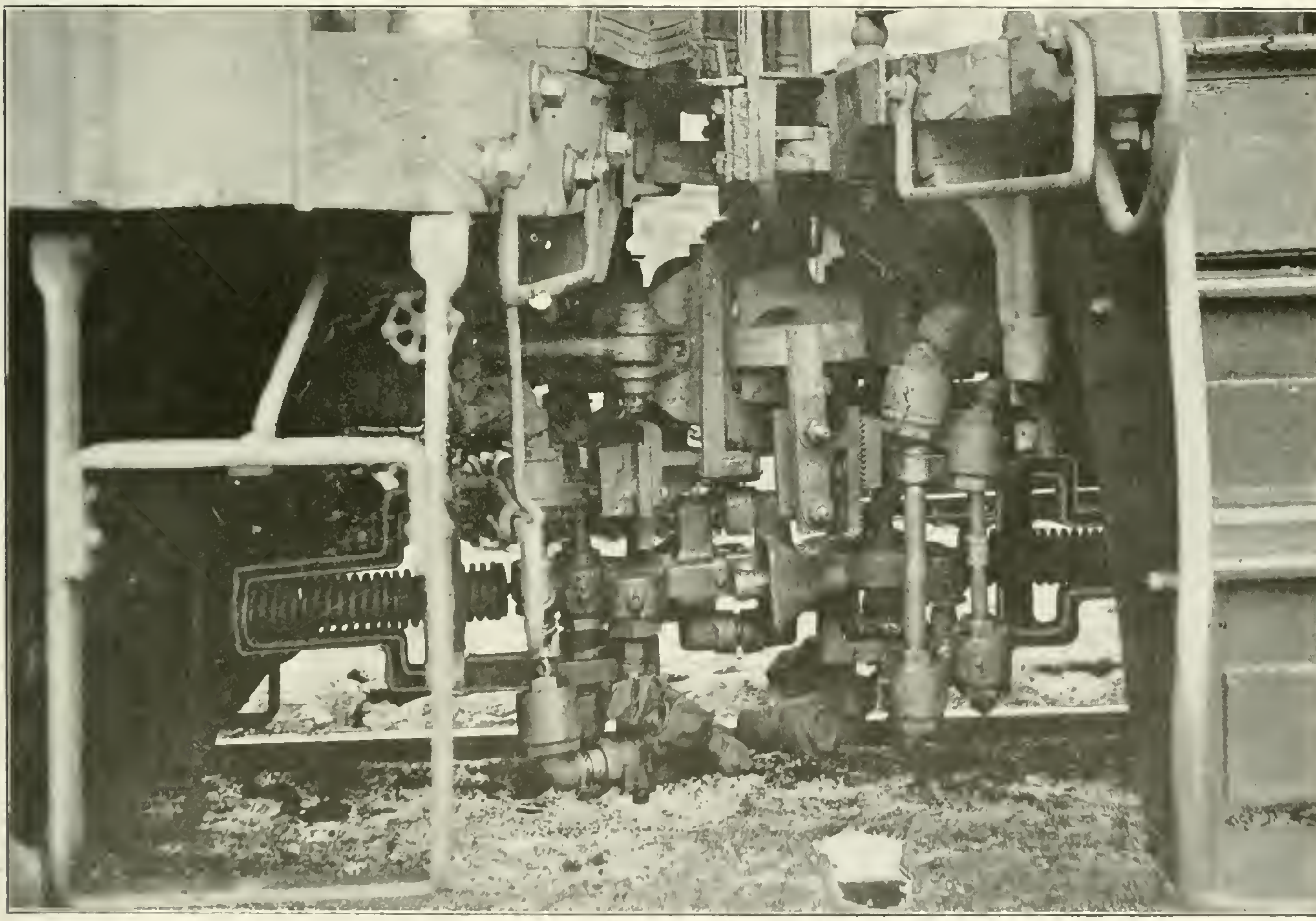
Principal Features Are Pin and Funnel Alining Device and Provision for Coupling to Air and Steam Hose

An automatic connector for train pipes, which embodies several interesting features, including a unique method of interchange with cars having standard steam and air hose, has been developed by Peter Beahm, Altoona, Pa., and was applied for test purposes under the direction of the Railroad Administration. The connector differs from other types in the gathering arrangement, in the method of attachment to the coupler and in the means employed for coupling to cars not equipped with connectors.

The connectors on adjacent cars are alined by means of a pin on the horizontal center line of the connector and some distance to one side, and a funnel on the opposite side having a rectangular opening leading to a central cylindrical opening. The funnels guide the pins so that the cylindrical end of the pin will enter the bore of the funnel. The ports in the connector are so located that they come into contact just before the couplers close and are held to their seats by the compression of coiled springs.

The bracket supporting the connector spans the head of the coupler and is held in place by a long knuckle pin. The bracket is so arranged that in case the pin breaks it is still held in position and the connector cannot fall to the track. The supporting bracket also carries an arm, on the end of which is a shoe, the shoe being clamped against the guard arm of the coupler by a set screw. The rear portion of the frame consists of a bracket provided with two vertical slotted plates. This bracket supports the main connector frame, which is provided with slotted projections having teeth to engage the bracket of the main frame. Thus the height of the connection can be adjusted independently of the coupler.

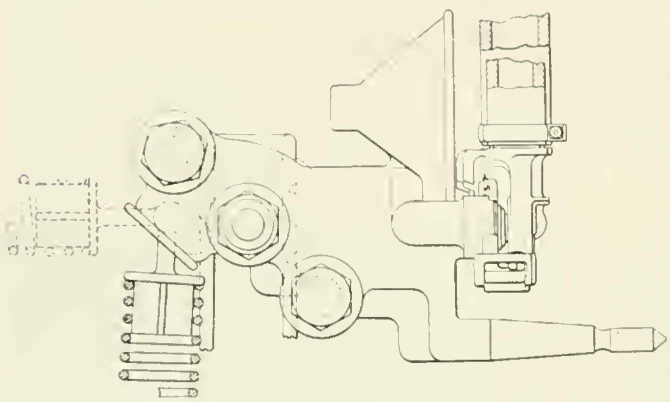
The main connector frame has two parallel horizontal members which terminate in a yoke having a boss at the center to receive the rear end of a coiled spring. The vertical guiding stem carrying the connector head fits in a slot in the upper portion of the frame and the carriage for the connector, which contains the gathering device and the parts, slides upon the lower frame member. On the rear face of the carriage is a socket into which fits a knob carried in the outer end of the coiled spring, which extends to the rear of the yoke. The spring holds the carriage at the forward end of the yoke, where its travel is stopped by the stem engaging the outer end of the slots. The socket and boss are offset slightly from the center line of the carriage and the form of the slot is such that pressure of the spring will hold the connector ports either on the center line of the car coupler or at a position approximately at right angles to the center line. The carriage is provided with three channels, the center one terminating in the air brake supply port, the



Cars Equipped With Beahm Connector Coupled Together

others leading to the upper air signal port and the lower steam heat port, all three being in the same vertical plane. On the ends of the carriage opposite the air brake and signal ports are lips provided with recesses for receiving the lugs of the standard air and signal hose couplings.

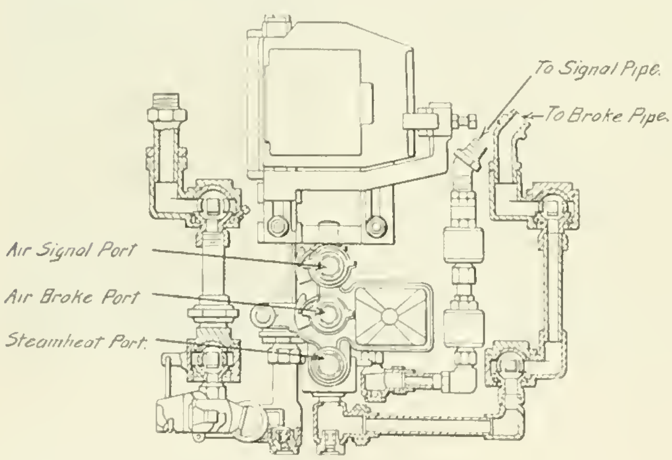
The channel for the air brake connection leads to the rear of the carriage, where it enters a vertical passage, which is closed at the upper end by a plug, while the lower end carries the condensation valve. This port is also connected by horizontal and vertical ball jointed pipes to the air



Plan of Connector Carriage Showing Method of Attaching Air Hose and Two Positions of Spring

brake line. The air signal pipe connections are similar to the air brake connections, except that no condensation valve is provided.

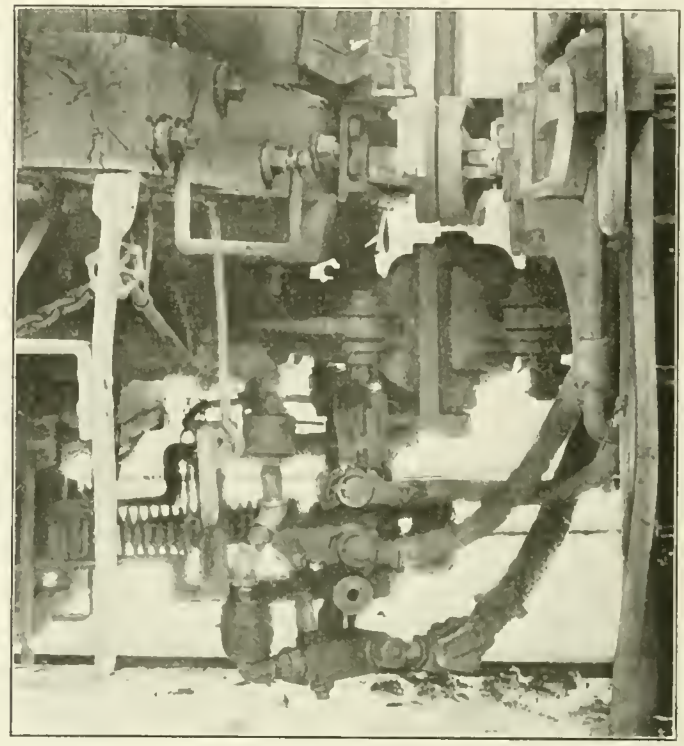
The steam heat connection is carried on the opposite side from the signal connection. A vertical pipe from the carriage leads to the condensation outlet valve and a casing having a hole for the reception of a plug cock and an outlet through the cock, which is connected to the steam heat line by flexible jointed pipes similar to the air brake and signal connections. The plug cock in the steam inlet casing carries a standard steam heat coupling, which is connected to a



End Elevation of Connector Showing Piping Arrangement

port in the key. When the cock is in the normal position and the carriage is in line to couple with connector-equipped cars, the steam passes through the cut-away portion of the cock directly to the port. In this position no steam can pass out of the steam hose coupling and it is held in place by a link attached to an arm on the steam pipe connection. When the connector is used with the ordinary form of coupler the coupling and the cock are turned through a half circle, when the port assumes a position that prevents the steam escaping to the port in the face of the carriage and opens a passage from the steam line through the steam hose coupling. The carriage can then be turned at right angles to the coupler center line, thus allowing air brake and signal hose to be connected to the respective ports.

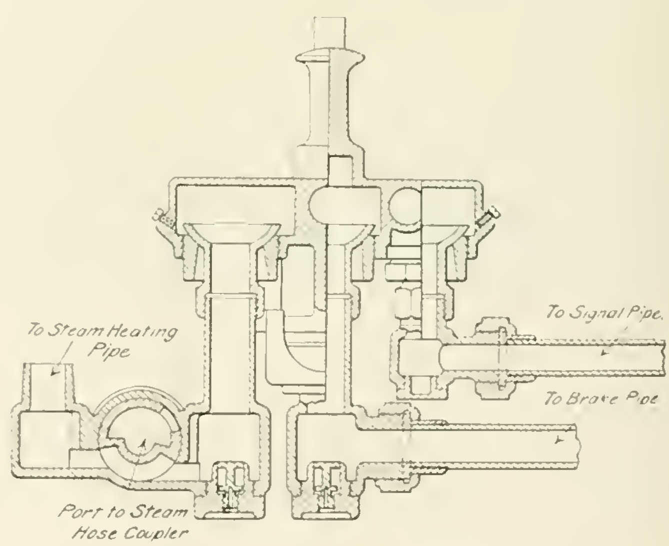
A special feature of the connector ports is the metal coupling ring which is provided with several concentric grooves.



Position of Parts When Coupled to Car Having Standard Hose Connections

In case dirt lodges upon the smooth portion of the ring the action of the opposing connector will cause it to be rubbed into the grooves, thereby eliminating leakage.

The connector, as will be noted, provides a complete metallic connection throughout the train. The joints in the carriage and the pipes are formed by removable seats into which are



Details of Connections to Coupler Carriage

seated hemispherical joints having a limited angular movement. These joints have no packing and are kept tight by the weight of the attached parts and the pressure acting upon them. This form of joint is an earlier invention of the originator of the coupler.

The Inspection of Freight Equipment

Handling Weak and Defective Cars. Preparing Equipment for Refrigerator and Heater Service

By L. K. SILLCOX

General Superintendent Motive Power, Chicago, Milwaukee and St. Paul

It has been found that bad-order cards on cars are sometimes removed by malicious persons and in some instances have been washed off by heavy rain. In order to overcome the embarrassment caused by the cards being removed, inspectors will arrange hereafter not only to card the cars, but also to mark them on both sides with chalk.

If a car has penalty defects or other safety appliance defects it should read "Bad Order, Safety Appliance Defects, Steps Missing," etc., or in case of defective draft gear, sills, etc., it should read "Bad Order, Handle With Care." These markings should appear on both sides of the car, so that there will be no opportunity for switchmen or trainmen to claim that the cars were not marked bad order.

Switching Defective Cars

Defective freight cars should not be switched in with good serviceable cars, in order to avoid damage to the serviceable cars. When defective freight cars are shopped out in the transportation yard, they should be placed on tracks designated for such cars, avoiding frequent handling of the defective cars and preventing further damage.

Location of Cars in Trains

Section 988 of Standard Rules and Regulations of the Operating Department reads as follows:

"The following cars, loaded or empty, will be handled next ahead of the caboose, giving preference in the order shown, except that at least one car must be handled between a flat car loaded with rails and the caboose. 1. Bad order cars; 2. Bunk cars; 3. All wooden flat cars; 4. Coal cars with temporary sides; 5. Oil and water tanks, except all steel or steel underframes.

"In addition to this, loaded or empty cars of 40 tons capacity or less with short draft timbers should be switched to the rear end of trains."

Switching Wooden Cars to Rear of Train

Car inspectors will mark all cars with short draft timbers for switching to the rear of the train when loaded and empty, provided they are to operate in trains of 65 cars or over. Car inspectors must be instructed to chalk-mark all cars with short draft timbers suitably on both sides, in plain legible writing stating whether they are to be switched to the rear, and if a load, marking them to be cut out when empty, besides taking down the car number and the date. All concerned must co-operate to see that cars are properly loaded to avoid embarrassment in service.

Switching Weak Cars

In cases where short draft timber cars are placed in long trains, and experience has dictated a policy of care, due to characteristics of the line, and it is felt economical to switch out weak constructed and equipment with short draft timbers to rear of train, this should be done. As a general plan, no train containing 65 cars or more should have cars with short draft timbers placed except at the rear. Cars which are to be switched to the rear will have the initials W. C. six inches high placed on the side of the car above each transom, this standing for weak construction.

Icing Refrigerator Cars

Standard Rules Regarding Re-Icing of Cars Containing Meats, Packing House Products, etc.:—The following rules must be observed:

For straight or mixed cars of fresh and frozen meat or dressed poultry, use crushed ice with salt.

Packing House Products:—Butter, eggs or cheese must be re-iced with crushed block or lump ice, with or without salt in accordance with railroad billing.

1. Quantity and preparation of ice, and grade of salt: Ice must be thoroughly cleaned by flushing with water, thus removing all foreign substances to prevent clogging of drains.

Description of Crushed Ice: Ice should be no larger than a man's fist.

Description of block ice: Ice should be broken in chunks weighing approximately 50 lb. and permitted to fall into tanks loosely.

Description of lump ice: Ice should be broken in chunks of 15 or 20 lb. When the railroad billing specifies the use of salt, follow the salting method described in paragraph four below.

Description of Salt: No. 2 rock salt must be used in accordance with instructions on railroad billing. Foremen should anticipate their requirements for salt sufficient in advance to insure an adequate supply.

2. Hatch covers and plugs removed: Extreme care must be used in the removal of hatch covers and plugs to prevent all foreign substances from dropping into tanks. Uncover only such tanks as can be immediately filled to prevent any unnecessary exposure. Plugs and covers are to be replaced at once after re-icing is completed. Plugs are to be fitted evenly and tightly in the tanks by lightly tamping with the tamping pole.

3. Release of excess brine: If tank valves do not work, excess water must be removed from tanks before re-icing is attempted. This can be accomplished by using a hand pump or bailing out with buckets; if the valves do not work, the next icing station must be notified by wire so that they can be prepared to remove promptly the excess brine before re-icing.

The A. R. A. Rules of Interchange, rule 3, paragraph f, require all beef refrigerator cars to be equipped with brine retaining valves to prevent brine dripping along the right of way between icing stations. When the plugs are pulled, excess brine is automatically released. Considering the large number of cars now equipped with this device, and the rule requiring all such cars to be equipped as fast as possible, it is necessary that each icing station procure a hand pump. Excess brine must be removed from the tank before re-icing is attempted.

4. Tamping and salting crushed ice: Foremen should see that a wooden tamping pole is used, and under no circumstances should they permit pike poles or poles with metal ends to be used. The tamping pole should be inserted into the old ice which should be thoroughly stirred and tamped to settle it to the bottom of the tank. After tamping, one third of the salt required in the re-icing is to be properly spread over the old ice before any more new ice is used. Then the tanks are to be filled with ice and the balance of the salt evenly spread on top of the new ice. The men icing the cars should again use the tamping pole vigorously to even off the top of the ice and start the salt working. They should see that the space between running boards is filled, but should not fill tanks above the top of the saddles.

5. Stations not equipped with an ice crusher, should secure the necessary wooden mauls and ice crushing boxes to insure efficient re-icing. Under no circumstances should ice be broken on the roofs or in the tanks of cars.

For ready reference the following table can be used to determine the amount of salt in pounds based on the quantity of ice supplied.

Salt Required for Various Percentages and Weights

Ice Pounds.	Five percent salt; lb.	Seven percent salt; lb.	Eight percent salt; lb.	Ten percent salt; lb.	Twelve percent salt; lb.	Fifteen percent salt; lb.
500	25	35	40	50	60	75
600	30	42	48	60	72	90
700	35	49	56	70	84	105
800	40	56	64	80	96	120
900	45	63	72	90	108	135
1.000	50	70	80	100	120	150
1,100	55	77	88	110	132	165
1,200	60	84	96	120	144	180
1,300	65	91	104	130	156	195
1,400	70	98	112	140	168	210
1.500	75	105	120	150	180	225
1,600	80	112	128	160	192	240
1,700	85	119	136	170	204	255
1,800	90	126	144	180	216	270
1,900	95	133	152	190	228	285
2,000	100	140	160	200	240	300
2,100	105	147	168	210	252	315
2,200	110	154	176	220	264	330
2,300	115	161	184	230	276	345
2,400	120	168	192	240	288	360
2,500	125	175	200	250	300	375
2,600	130	182	208	260	312	390
2,700	135	189	216	270	324	405
2,800	140	196	224	280	336	420
2,900	145	203	232	290	348	435
3,000	150	210	240	300	360	450

Preparation of Cars for Heater Service

All ice and inflammable matter must be removed from bunkers and drip pans, all doors and hatches tightly closed. Bulkheads must not be lined with paper when heaters are to be placed in the bunkers. In order to permit circulation of air, the drain pipes should be cleaned and left open before and during the process of loading, as well as while cars are in transit. When cars with ice tanks are used, heaters should be placed in ice bunkers of cars and securely braced.

Charcoal Heaters

When refrigerator cars contain ignited charcoal heaters, placed in ice tanks, the hatches must be left open a few minutes before entering the tanks or bunkers of the car. All persons are warned against remaining in cars with doors or hatches closed while charcoal heaters are burning and to use caution on entering cars under such conditions.

Care of Charcoal Heaters

In selecting and preparing fuel for both the Cole and Baxter types of heaters, charcoal of good quality, absolutely dry, free from knots and reduced to the size of a walnut should be used. The efficiency of the heater depends largely upon using charcoal of proper quality and size. Charcoal dust must not be used in the magazine. Charcoal must be stored where it will keep perfectly dry.

Operation of Cole Heaters

(a) To fill the magazine shove in the cut-off slide and fill the magazine with prepared charcoal, free from dust, as dust will choke down the fire. The cover of the magazine must be kept closed absolutely tight while the heater is burning. This is essential to prevent a draft of air from the fire pot up through the magazine. When it is necessary to open the cover to replenish the charcoal, that must be done quickly and the cover again closed without delay.

(b) In order to start the fire, remove the fire pot and fill it not to exceed 2/3 full of clean charcoal free from dust. Replace the fire pot, remove the starting lamp through the ash pit hand door and saturate with alcohol. Light and replace the starter, then put on the magazine section and lock the heater with the pin. Pull out the slide (secured by a pin) in the magazine and see that the fuel feeds down and close the ash pit hand door.

(c) In regulating the draft slide, set it either at full heat or slow heat as conditions require. Remember that the fuel always heats up considerably hotter during the first 12 hours with either draft position.

(d) Kerosene or papers can be used in starting the fire, but will cause considerable smoke until burned out. Be sure that the heater has a good start before placing it in the car. The heater can be nailed to the floor, swung from chains from the ceiling of car or anchored in the bunkers of the car by chains. The ash pit door must always be closed except when removing ashes or the starter. The top feed lid must always be closed tight to prevent burning in the magazine. To extinguish the fire, simply remove the pin and shove in the cut-off slide. Remove the ashes at least once a week and never dump them on the car floor nor on wooden platforms or ties. Some ashes retain fire hours after dumping.

Operation of Baxter Heaters

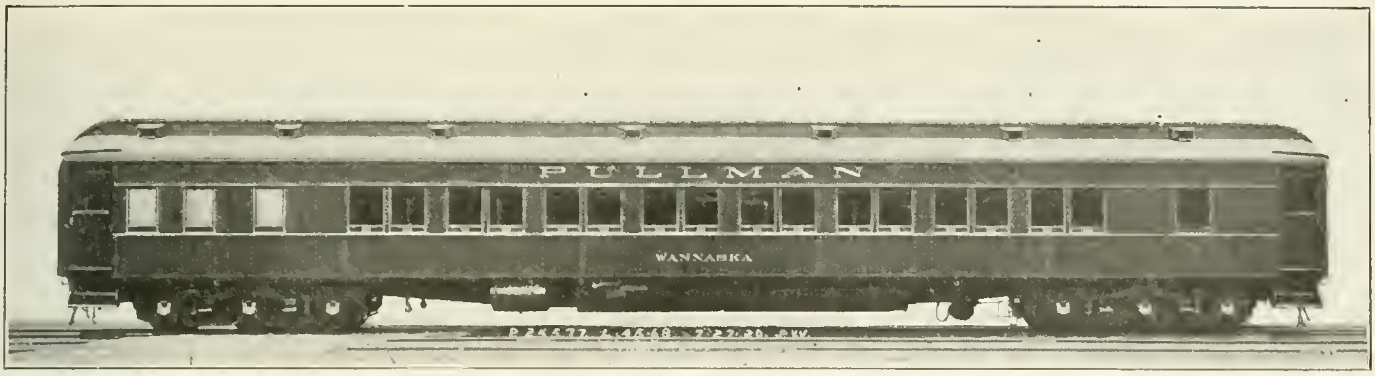
The fire in the heater can be started in the car, but the door or hatches in the car must be left open to give a draft and allow the escape of gas. It is better practice to start heaters on platforms in the open air.

The procedure is as follows: (1) Remove the magazine by unfastening the hasps at the bottom and lifting off. (2) Punch a hole in the center of the paper starter and light there, then place on the grate in the bottom of the fire pot and put three or four handfuls of charcoal or briquets on the starter and let it burn a few minutes. (3) Fill the fire pot and let the blaze show before putting on the magazine. This will usually take about ten minutes. (4) Put on the magazine and fasten the hasps at the bottom, then remove and fill the cover, shaking a little to fill to capacity. Replace the cover quickly and see that it is on tight. Do not use charcoal dust in the magazine. If the heater has a shut off slide, pull it out and place a pin to keep it open.

Handling Road Work

Men doing road work often cannot get into their home station without making unavoidable overtime, due to lack of convenient train service. There is only one means to resort to in combating this condition, namely to see that where men lay over at any station, they take it upon themselves to go over any cars which are located adjacent or within easy reach of the car which they repaired, giving them such necessary attention as to fit them for service, besides making every adequate repair within their power to the cars which they were sent out to take care of. Good judgment is necessary and roadmen should be checked up to see how many work cards they deliver showing actual repairs made. They should carry sufficient cotter keys, nuts, small bolts and other items with them so as to provide for any eventuality. In any case, they can take care of the packing on a number of cars without additional material, all of which should be properly reported. All supervisors should interest themselves to the extent of seeing that this matter is followed up from day to day. There is always a proportion of the expense chargeable to transportation accounts, namely, that spent in the attention given oiling and packing of boxes, closing side doors, classifying cars for various loading, etc.; of course, the time actually spent repairing the equipment is chargeable to car repairs.

It is not proper to send men out on the road to repair cars with broken train lines, defective air brake equipment, framing or truck members, if it is at all possible to get the car safely to some repair station by hauling it behind the caboose, care being exercised, of course, to see that loaded cars are not delayed unnecessarily and back-hauled too greatly in case there are no means available for turning the car.



Latest Type Pullman Sleeping Car

IMPROVEMENTS IN NEW PULLMAN SLEEPERS

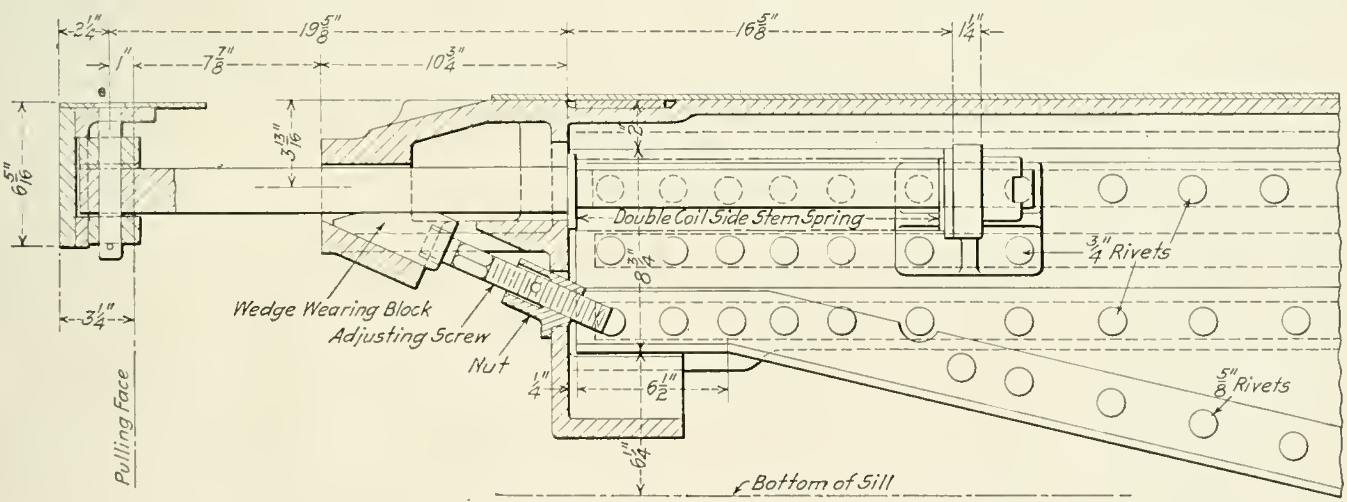
Changes in Details Which Have Been Developed to Add to the Comfort and the Safety of Travel

ALTHOUGH no changes in basic design have recently been made in its equipment, the Pullman Company has been constantly working on the development of detail improvements most of which have had for their object an increase in the comfort or safety of the occupants of Pullman accommodations. A number of changes of this nature have been incorporated in the new sleeping cars which the company has been building at its Pullman works, Chicago, since the return of the railroads to private operation.

Diaphragm Mechanism

The metal diaphragm is now a standard feature of Pullman car construction and cars equipped with these diaphragms have been in service several years. The clearance between the diaphragm and the sides of the narrow metal pocket within which it telescopes is necessarily limited. But the method by which these diaphragms have been supported has permitted considerable lateral motion at the top and this has tended to increase rapidly as the buffer side stems wear into the surfaces of the openings in the platform end casting through which they pass. These conditions have resulted in the constant slamming of the diaphragm against the sides of the pocket and the noise thus caused led to numerous complaints.

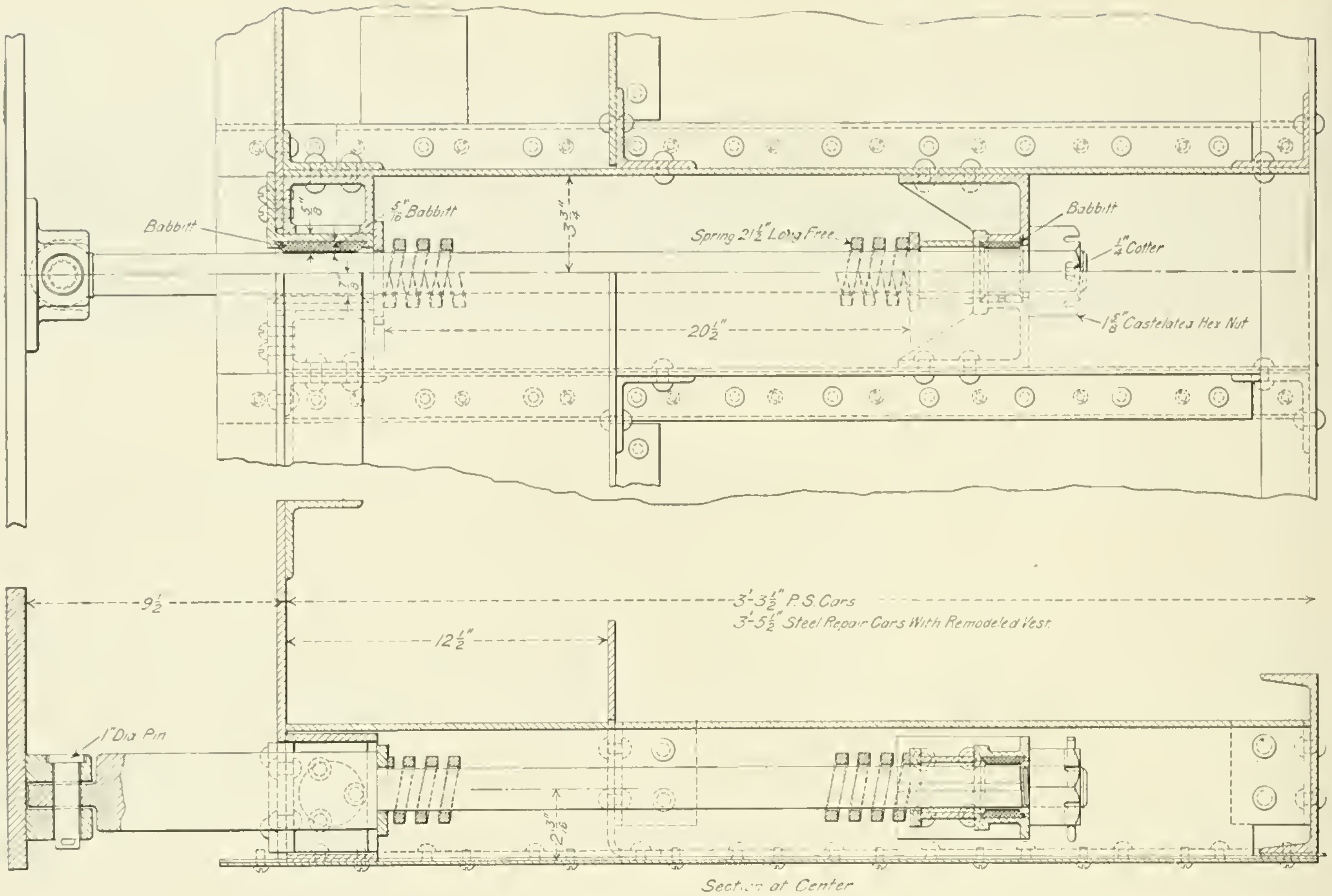
In the new cars both the upper and lower diaphragm buffer mechanisms have been arranged to maintain the alinement of the diaphragm within the limits of the clearance in the pocket, thus eliminating the greatest source of noise at the ends of the car. In this design provision has been made to take up wear so that the diaphragm may be readily restored to its normal position as frequently as conditions require.



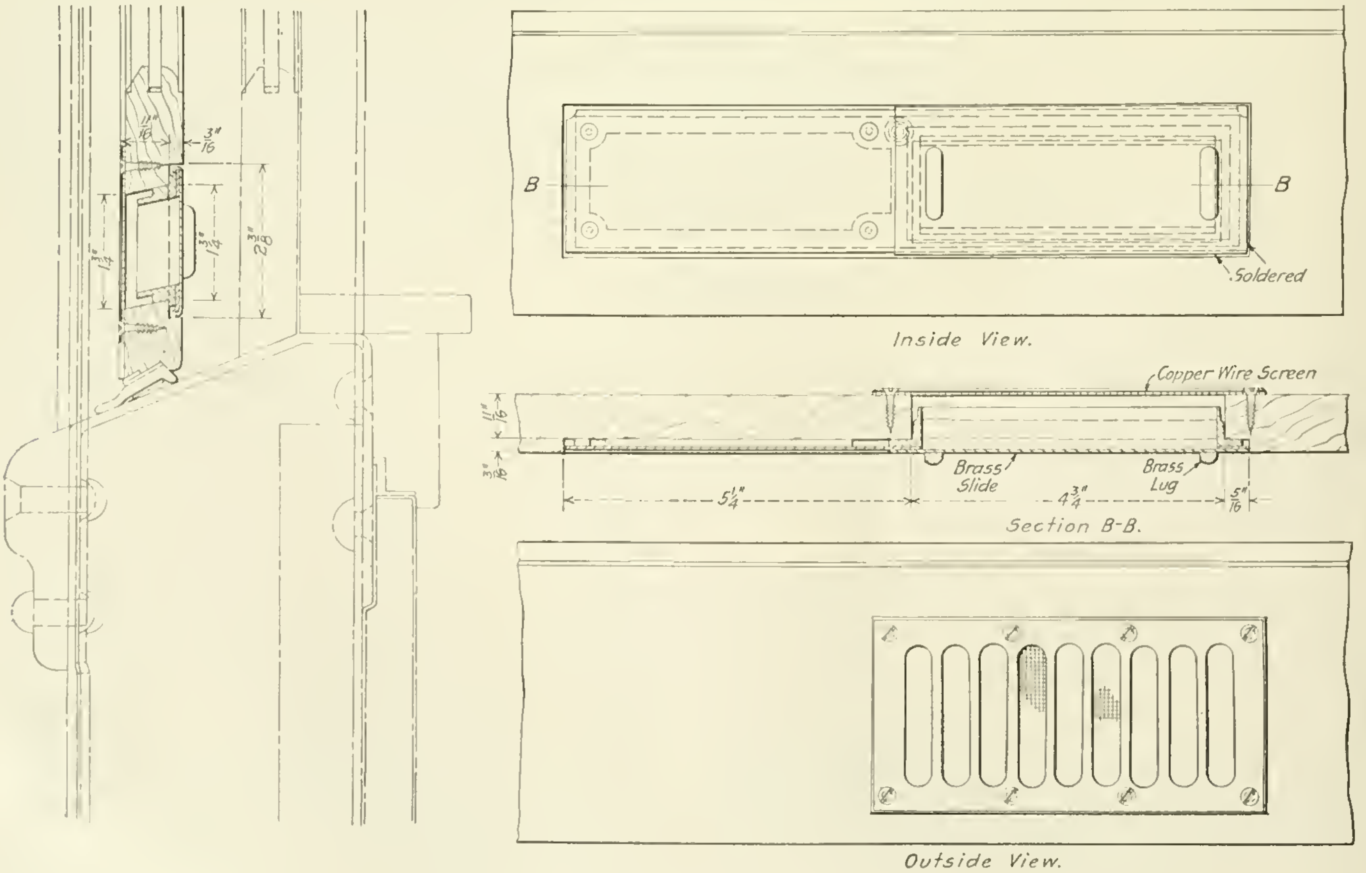
Section Through the Lower Buffer Side Stem, Showing Wear Adjusting Screw and Wedge

The height of the diaphragm is controlled by the surfaces on which the buffer side stems rest. In the new cars these stems are supported on adjustable shims or wedge blocks let into the platform end casting and adjusted as shown on one of the drawings. The adjusting device consists of three pieces, the shim, the adjusting screw and the nut. The parts are readily assembled or removed by turning back the adjusting screw into the nut, which permits the nut to be inserted or lifted out of the opening in the casting. The shim is then free to drop out. When properly adjusted the screw is prevented from turning back by a cotter which passes through slots in the extended portion of the nut and one of two holes drilled through the screw at right angles to each other.

Upper diaphragm buffers either of the semi-elliptic spring type or of the stem and coil spring type have never pro-



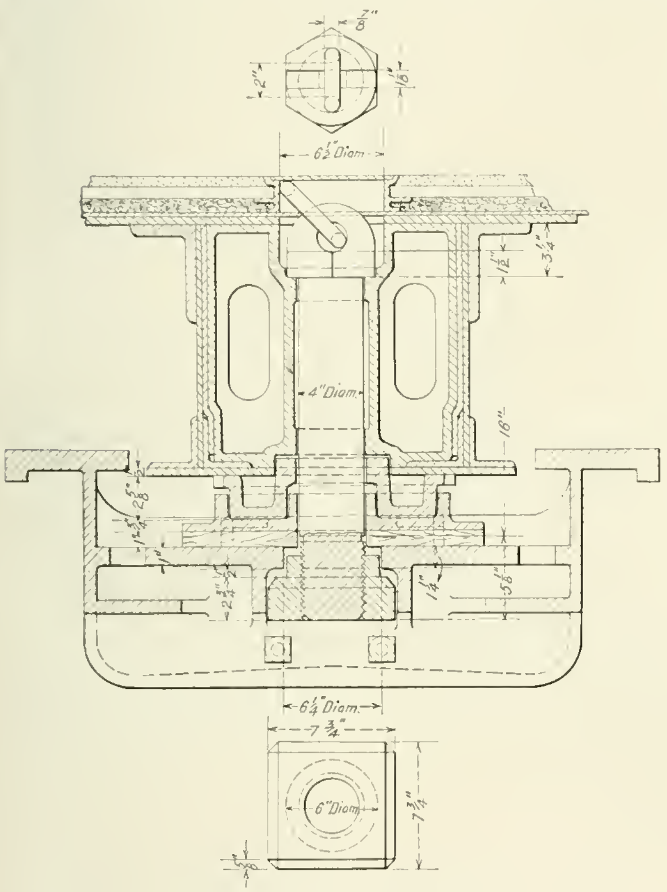
Single Stem Diaphragm Mechanism With Babbitted Center Plates



Ventilator Applied to Loweer Rail of Outside Sash

vided a satisfactory means of centering the top of the diaphragm. Consequently the entire reaction from the lateral force at the top of the diaphragm caused by the swaying of the cars has been taken by the buffer side stem supports. This has caused excessive wear and a rapid increase in the lateral movement at the top of the diaphragm.

To overcome this a single stem upper diaphragm mechanism has been designed in which the stem is restrained between lateral bearings where it emerges from the end of the car. These bearings are removable malleable iron castings faced with babbitt, inserted from the outside and held in



Locked Center Pin With Full Diameter Effective for Stress Resistance

place by machine screws applied through flanges to the end of the car. When worn they are readily replaced, and after rebabbitting are ready for further service. The buffer stem rear guard is also lined with babbitt, but this casting is riveted in place and is not designed for removal between shoppings.

Sash Ventilators for Lower Berths

Although an extremely simple device, the sash ventilator which has been placed in the lower rail of the outer or storm sash of the car windows is one which immediately appeals to the occupants of lower berths and it has already been the object of a number of individual expressions of appreciation from the traveling public.

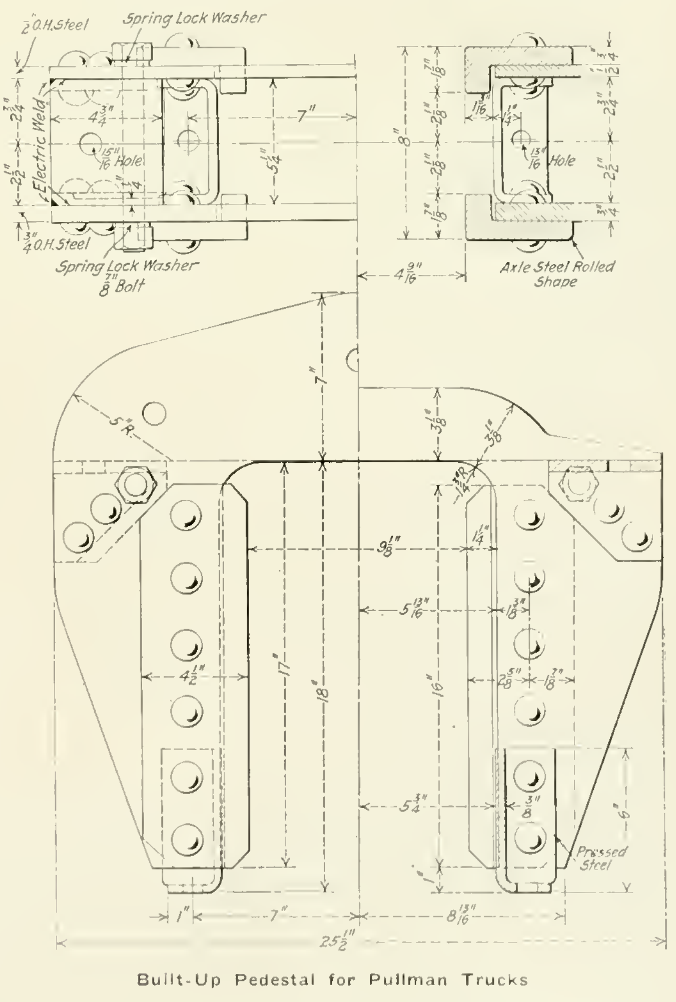
The difficulty in always securing satisfactory ventilation and temperature regulation in lower berths during the seasons when heat is required and the windows are normally kept closed is well known. Under these conditions the only recourse of the occupant of a lower berth who wishes additional ventilation is to raise the inner sash and then slightly open the outer sash, adapting some portion of his personal belongings to serve as a stop to prevent it from working shut. The ventilator furnishes a screen protected opening, closed with a horizontally operating slide, which provides easy and close regulation of the amount of air admitted.

The Locked Truck Center Pin

While it is impossible to design equipment strong enough to resist destruction under all conditions of collision impact, it is generally recognized that anything which will tend to hold the underframes in the same horizontal plane will exert a powerful influence in the prevention of telescoping, the form of destruction usually responsible for the greatest loss of life in train accidents.

The use of a locked center pin as a means of resisting the tendency of one underframe to climb over the top of another has received considerable recognition and at least one self-locking center pin has been developed. The locked center pin is effective only so long as it holds the truck and car body together. The self-locking type is open to the possible objection that the full area of the pin section is not available to resist tension or shearing stresses and therefore under certain conditions might not be as effective in preventing a separation of the truck and car body as a pin of solid section.

These considerations have led to the design of the center



Built-Up Pedestal for Pullman Trucks

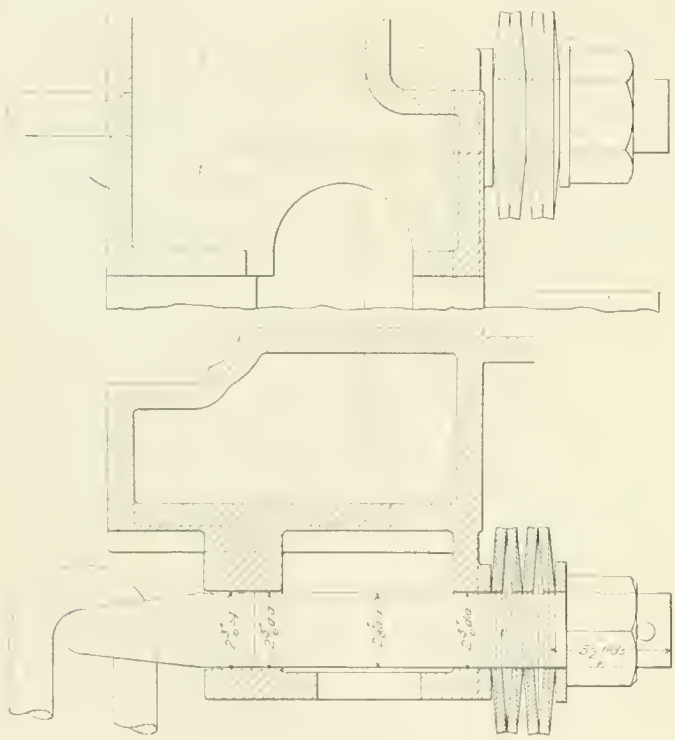
pin shown in one of the drawings. The pin is a forged steel bolt four inches in diameter with a shallow hexagonal head and a square nut of special design. The head sets in a shallow hexagonal socket at the bottom of a pocket in the center sill filler casting. The nut is placed in a square recess in the under side of the truck bolster and two 7/8-in. bolts applied through flanges of the bolster casting hold it in position when the center pin is not in place. In applying the bolt it is dropped in place and screwed into the nut,

which is held in sufficiently close alinement by the square recess in which it is placed to prevent any difficulty in starting the threads. When drawn up as far as it is possible to turn the bolt, the head is brought into register with the socket and dropped in. This locks the bolt and nut except for the slight turning of the nut due to the curving of the trucks, which it is expected will prevent the nut from sticking and causing trouble when removal is necessary.

The use of check chains has been dispensed with and a plate on which is cast in raised letters the legend, "Locked Center Pin, Remove From Inside," is attached to both side frames of each truck between the center and inner pairs of wheels.

Built Up Truck Pedestals

In order to overcome the occasional failures of cast truck pedestals which have occurred in service a pedestal built up of plate and rolled and flanged sections has been designed and applied to the new equipment now being built. The outside and inside plates are of ¾-in. and ½-in. open hearth steel, respectively, and are separated by steel pressings at the top and bottom. The top pressing is of one-half inch material and is electrically welded and riveted in place. The lower pressing is of ⅜-in. material. The jaw faces are formed by two rolled steel pieces of special angle section which are riveted to the outside of the plates with the short legs turned in. These pedestals are built up and applied as units.



Application of Safety Chains With Spring Washers

Safety Chain Application

One of the interesting details in the construction of these cars is the use of spring washers on the safety chain anchor bolts. The application is shown in detail in one of the drawings. The washers are 6 in. in diameter and are cupped to a depth of 5/32 in., each, thus providing for a full load travel of the safety chain bolt of ⅝ in. This arrangement, which is common in European practice, acts as a cushion for part of the shock to which the chain and bolt are subjected when brought into action by a failure of the coupler. In the application shown these washers have a full load capacity in the ⅝ in. travel of approximately 50,000 lb.

PREPARATION AND APPLICATION OF JOURNAL BOX PACKING

BY NORMAN McCLEOD

The arrangement for soaking oil is an important adjunct to all modern oil houses. The drawings accompanying this article show three designs of cans and boxes or tanks for soaking and draining the packing, each having its peculiar advantages. The plain box, Fig. 1, and cans shown in Fig. 2, are in extensive use and are satisfactory for properly soaking and draining the packing for cars and locomotives, but are more or less crude in comparison with the method shown in Fig. 3. With equipment shown in Fig. 1 the packing must be handled from soaking compartment

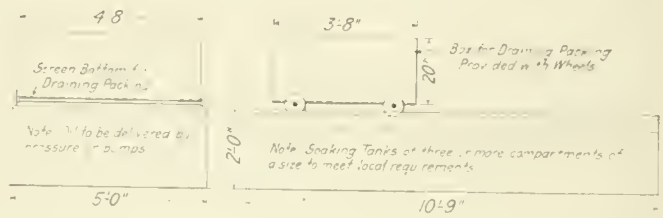


Fig. 1—Soaking Tanks With Portable Draining Boxes

to drainage tray, which becomes a more or less untidy operation, but with the cans, Fig. 2, and vat system, Fig. 3, it is not necessary to handle the packing, except to take it out when it is to be used, as it is soaked and drained in the same compartment.

In Fig. 1 it will be noticed that the soaking tanks are made up of three compartments of a size to meet local requirements, the oil being conveyed to them from the oil storage tanks by pressure or by pump, as desired. Provision is made for a portable tank or box on wheels, as shown in Fig. 1, to facilitate its movement over the various compartments. The bottom of this portable box should be made of a suitable screen, strong enough to sustain the weight of the oil soaked waste. The size of the box as shown is 20 in., by 3 ft. 8 in., by 4 ft. 0 in. This, of course, as well as the size of the soaking tanks, depends on local requirements.

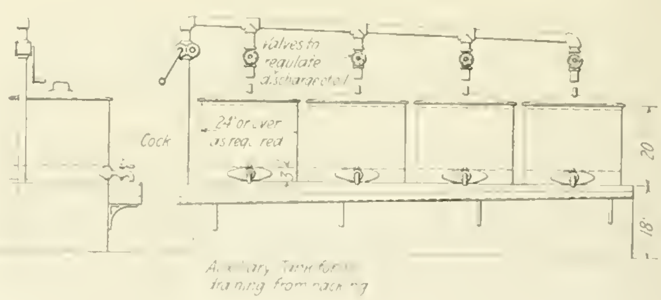


Fig. 2—Arrangement for Soaking and Draining Packing Without Removing from Cans

The arrangement shown in Fig. 2 represents a step in advance of that just described, in that the tanks or cans are separated and are provided with a screen three inches from the bottom of the can, to which the oil returns after percolating through the waste, to be drawn off into an inclined trough by which the excess oil finally reaches an auxiliary tank, shown in dotted lines in the front elevation. If desired, this tank can be provided with a vertical graduated scale, thus allowing a check to be kept of the amount of oil absorbed. Provision is made in this plan for the return of the oil from the auxiliary tank to the soaking tanks by the use of a rotary pump as shown.

In Fig. 3 is shown a more advanced type of apparatus for this purpose, which allows of greater rapidity in soaking

and pressing out all surplus oil, the pressing being done by a portable air cylinder, or by hand power if air is not available. The cylinder is arranged to travel over all the vats, as outlined in the drawing. Each vat is provided with a perforated bottom placed six inches from the base. From this space the oil is drawn through faucets as shown. Provision is made for the oil, which naturally accumulates above the pressing plate, to reach the oil space below, by having three-inch galvanized iron strips, perforated the full length, placed in each corner of the vat as is clearly shown in the plan view.

Each vat should be provided with a scale of gallons so that the amount of oil used may be known if desired. This latter plan is the best for large car receiving and repair yards, and has been used for some time and with most satisfactory results on a number of important western railroads. The arrangement has many advantages and is worthy of consideration for all important oil houses.

The way in which the work is handled has an important bearing on the results secured, regardless of the equipment or the materials used. The method of packing boxes described below and the tools illustrated have proved effective in securing the best results in lubricating cars and locomotives.

Preparation of Sponging or Packing.—The waste must be separated in small quantities, but never rolled in bunches and must not be cut. It must then be submerged in freight or coach oil, according to requirements not less than 48 hours and kept submerged in oil until used. Before using, the surplus oil must be drained off, allowing a sufficient amount to remain, which is approximately equal to three pounds of oil to one pound of waste for freight cars and tenders, and three and a half pounds of oil to one pound of waste for passenger cars. The sponging while being used, must either be turned over periodically in the tank or the oil raised from the bottom of the tank and poured over the top of the sponging to keep all of the waste and oil in the tank properly mixed for use. Old sponging removed from locomotives and cars should be examined and the waste found in good condition should be cleaned, picked apart and again used for packing purposes. In no case should valve oil be used to saturate waste for packing purposes.

Method of Packing Journal Boxes.—All extra oil should be wrung or pressed out of a portion of waste, forming it into a loose rope. This should be packed tightly around the back end of the box, to assist the dust guard in retaining oil in the box and in excluding as much dirt as possible. The box should then be packed with loosely formed portions of the sponging to insure holding it in contact with the journal, being careful not to set it above the center line of the journal. The packing should not be entered between the journal and the side of the box, but should be entered directly under the front of the journal. This packing should extend well out to the front of the journal, as shown in Fig. 4, and should be packed back of the collar.

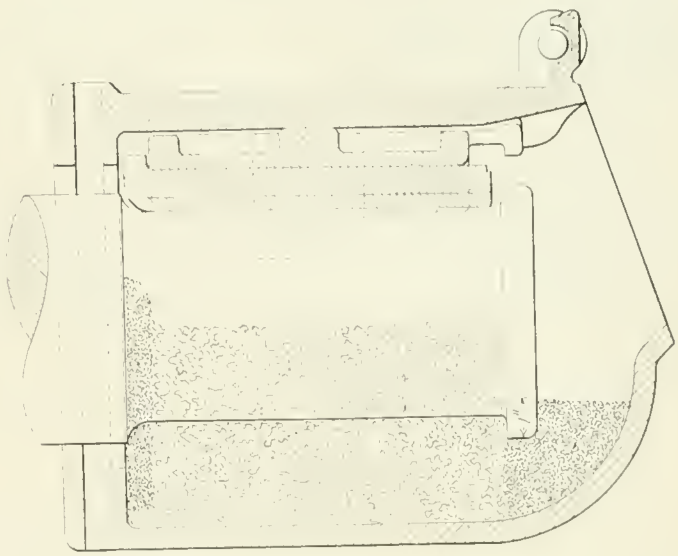


Fig. 4—Arrangement of Water in a Box Properly Packed

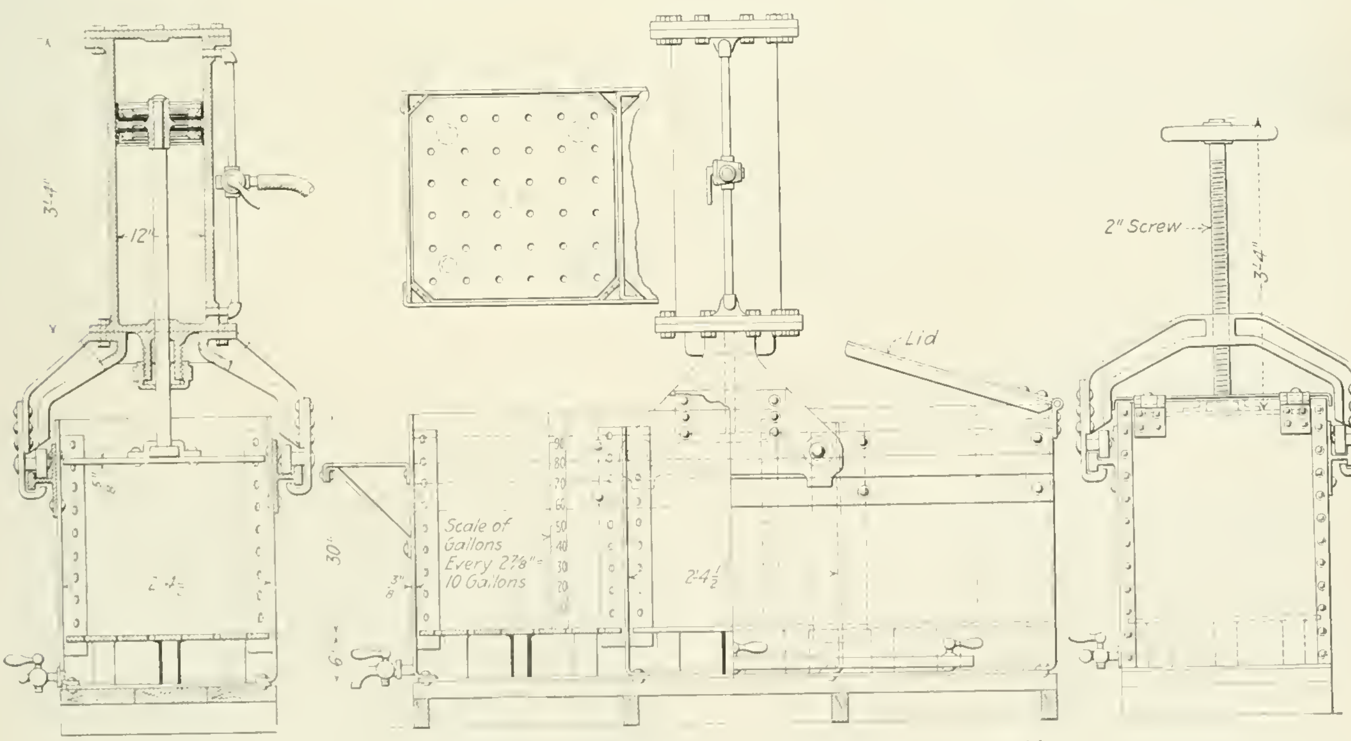


Fig. 3—Tanks Equipped with Press for Preparing Journal Box Packing

The sponging between the end of the journal and the in-

side front face of the box should have no connection with the sponging under or on the sides of the journal, as this sponging affords no means of lubrication to the journal, but is simply to prevent the sponging under the journal working out of position. For passenger and locomotive tender journal boxes the sponging between the end of the journal and the inside front face of the box should be formed of waste in the shape of plugs wound with cord, in order to facilitate their removal for the purpose of examination and setting up of packing.

When old sponging is reclaimed sufficient oil should be added to bring it to the same degree of saturation that is required for new waste.

Figs. 5 and 6 represent a variety of steel packing tools for use in packing car and locomotive tender journal boxes. Nos. 1 and 2 are for use in shops and car repair yards, where this work principally consists of the entire repacking of boxes. Tools 3, 4 and 5 are assigned and extensively used for the proper care and treatment of packing by oilers or inspectors in yards or cars in transit.

Two designs are shown, Nos. 3 and 4, which combine

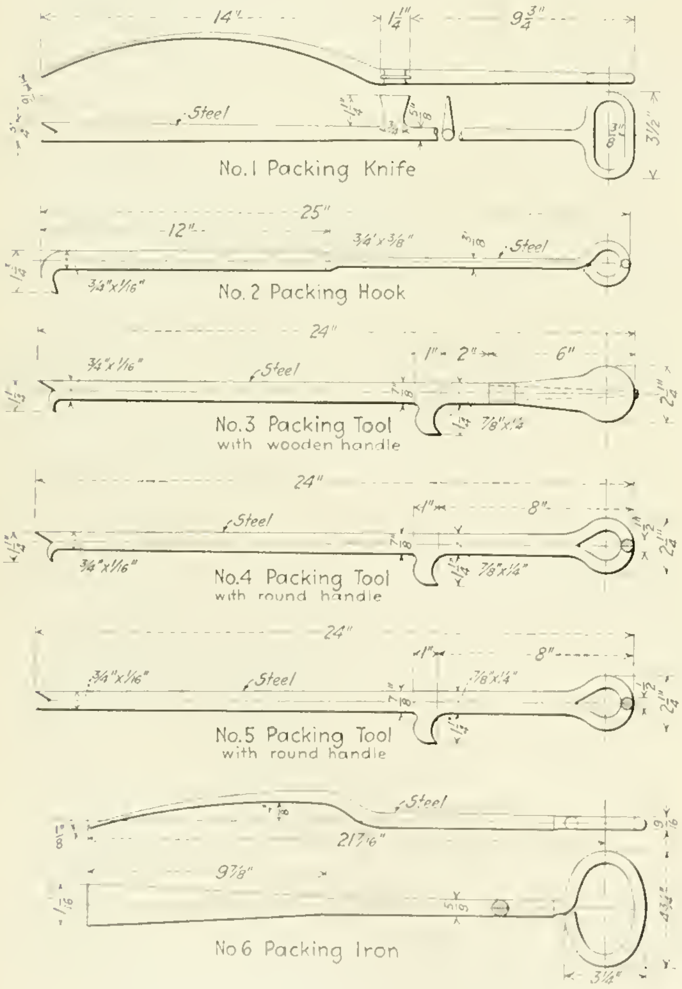


Fig. 5—Efficient Tools for Packing Journal Boxes

the features of Nos. 1 and 2, enabling a man with one tool to either quickly remove surplus packing with the hook edge of the tool, or to loosen the packing on the sides of the box and restore it to its proper position at the rear of the box with the spur edge of the tool. The handles of these tools differ, some preferring the wooden to the metal handle. Tool No. 5 has a V-shaped end and is in very general use in place of tools Nos. 3 and 4. Tool No. 6 has also been found desirable for the treatment of packing boxes.

A tool of either of these designs made of steel, should be used for rapidly and effectively maintaining the packing in an elastic condition and thus avoiding glazing and securing a more rapid flow of oil from the packing to the journal.

Tools Nos. 1 to 6, designated for driving boxes, are used for care of packing in driving box cellars of locomotives,

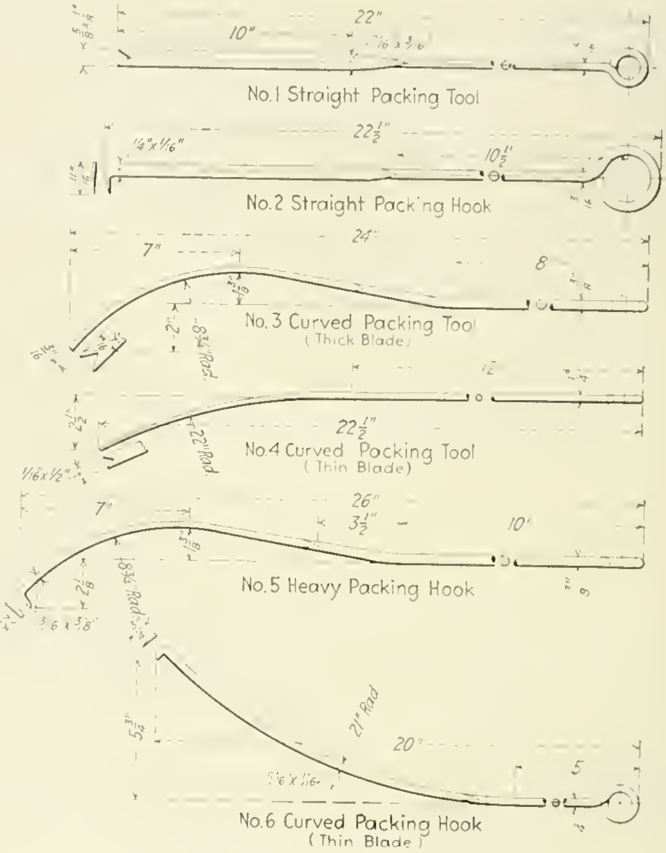


Fig. 6—Packing Tools for Locomotive Driving Boxes

and have been found very effective. Tool No. 6 is used in removing packing drawn up by the journal and caught by the lower edge of the brass; this tool has been found valuable in enginehouses on locomotives in passenger service.

Photograph from Underwood & Underwood, N. Y.

Salvaging Railway Property in Dublin from Freight Cars Which Were Set on Fire by Irish Incendiaries

HACK SAW BLADES AND CUTTING PRESSURE*

Too Little Pressure on Hack Saw Blades Is as Bad as Too Much; Work Must Be Held Properly

ONE of the most important factors in efficient cutting with a power hack saw machine is the maintenance of the proper pressure on the blade during the whole of a series of cuts. Failure among hack saw users to realize this fact causes big waste of blades and time, a waste far greater than is generally supposed. The maximum efficiency is to be found in the saw that cuts quickest and lasts longest; that combines cutting efficiency with endurance. The ability to cut in the shortest time is but one of three objects that determine the value of a hack saw and, when time is only considered of value, the chances for a loss of efficiency are exactly two out of three.

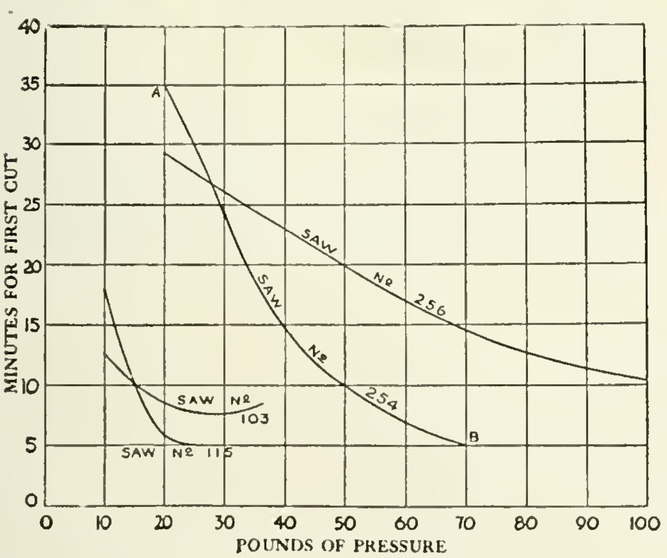


Fig. 1.—Chart Showing Relation Between Pressure on Blades and Time Required to Make Cuts

The effect of the regulation of weight on the time per cut is clearly shown in a recent test made to determine the results of various pressures on a number of blades. The test results are shown graphically in Fig. 1. In this experiment a new blade was properly placed in a hack saw machine, a piece of 3-in. machine steel put in the vise, the weight set at 20 lb., and a cut made. The time required for the cut was 35 min. Another blade was then placed in the machine, the pressure increased to 25 lb., and another cut made. The time required was 30 min. With the 30-lb. weight, a new saw completed the first cut in about 24 min. Another saw was inserted, the weight increased to 40 lb., and the time of the first cut was reduced to 15 min.

Effect of Too Much Pressure

The next increase was to 44 lb., which is the weight recommended for this particular saw, and a new blade made its first cut in 11 min. 30 sec., which is slightly better than a good average time for a first cut on this size and class of material. The weight was then increased to 50 lb., and subsequently, in increments of 10 lb., to 70 lb., a new blade being used each time, and the time of the first cut noted. While the time per cut continued to decrease as the weight increased, the saw in each case was actually cutting at a destructive rate when the weight was increased beyond the amount recommended for that particular blade. Had any of the saws used been tested for the number of cuts per blade and general efficiency, it would have been seen that when the weight rose above 70 lb. in the first cut, the life of the saw was considerably shortened.

While a hack saw must be made to withstand a great amount of abuse, there are limits beyond which it will not go; and where a saw is forced to cut under a greatly excessive weight the gain in time per cut may not offset the loss in saws, spoiled stock, etc. On the other hand, mere endurance without cutting effect, as exemplified in a saw that is worked too "gingerly," does not represent efficiency.

Insufficient Pressure

In a test to determine the results of insufficient pressure, the conditions were exactly opposite to those of the preceding experiment. A weight was applied in each case which was considerably less than that recommended for each particular blade used in the test and the results are shown in Fig. 2. Not only was the time per cut far in excess of what should have been required to cut the class of material on which the test was made, but the life of the saw was decreased almost as rapidly as when too much weight was used. The teeth of the blades were destroyed by slipping and sliding over the work, rather than by cutting.

*Abstracted from "Hack Saws and Their Use" by the L. S. Starrett Company, Athol, Mass.

These results make it evident that using too little pressure is almost as inefficient and costly as using too much, while the practice of using insufficient pressure has not even the doubtful advantage of saving time at the expense of the blade and stock, as is the case where too much pressure is employed. Between these two extremes lies the happy mean which represents the acme of hack saw economy.

The actual pressure in lb. per sq. in. of contact area of the tooth, which has been found to give the most satisfactory results as regards both the time per cut and the number of cuts per saw, varies from 20 to 30 lb. It has been determined by careful tests that pressures within these limits, while not overloading the saw, are sufficient to avoid any possibility of the blade slipping and sliding over the work, and thereby becoming dull without having worked to more than a portion of its rated capacity. It has also been found that the basic weight or pressure is directly proportional to the gage of the saw. Standard practice indicates using the 20-lb. unit of pressure for blades not over 0.040 in. thick, and 25 lb. for saws between 0.040 in., 0.060 in. and over.

This so-called unit or basic pressure must not be confused with the weight actually resting on the blade when in use, but must be taken as a constant, by the use of which the actual pressure on the saw may be calculated. The weight, or pressure, is measured by attaching a spring balance to the forward end of the saw-frame, when the blade is in mid-stroke, and lifting. The amount of pull indicated by the needle of the scale is the weight on the blade.

A workman, using a hand frame, almost instinctively bears harder upon the blade as the work progresses and the teeth lose their first keenness. This same principle of gradually increasing the pressure after the first few cuts must be applied to the power saw if efficient work is to result. No matter how nearly correct the weight is at the outset after a certain number of cuts have been made, the pressure must be increased, not only for the sake of reducing the time per cut to a point within the limits of efficiency but also to prolong the life of the saw.

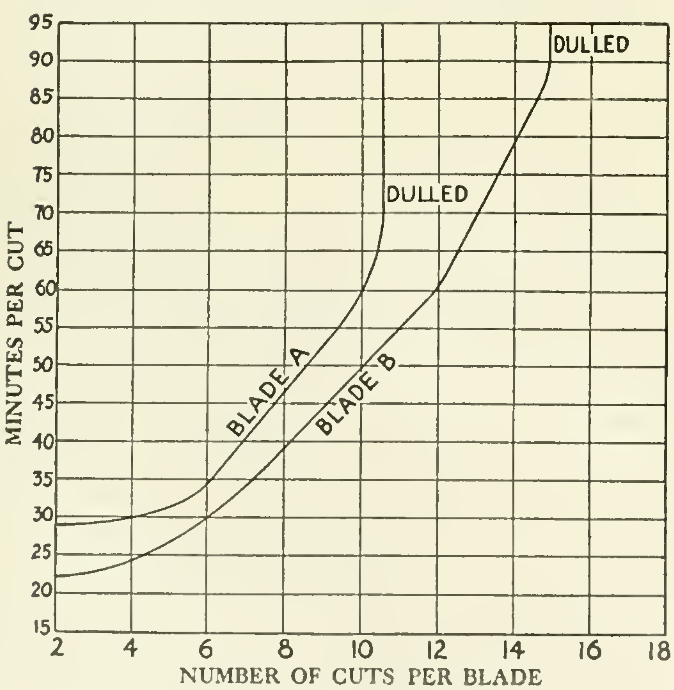


Fig. 2.—Results of Too Little Pressure on Blades

Increase Pressure With Number of Cuts

A saw wears as it is used, and the area of the teeth in contact with the work becomes greater as the number of cuts increase, and therefore, in order to maintain the same cutting speed, the pressure must be increased from time to time. It may be taken as a maxim of hack saw thrift that, for efficiency, the weight must be increased as the number of cuts progresses.

In connection with the necessity for the proper adjustment and increase of weight it is interesting to note that equal diameters of work of the same material will be cut at about the same rate, without regard to their comparative shapes. That is, $1\frac{1}{2}$ in. square, round, or elliptical bars of the same grade of steel would cut at the same rate. Angle irons, channels, and tees of the same greatest dimensions, will cut about alike, provided they are properly placed in the vise. Proper and improper methods of holding different shapes are illustrated in Fig. 3.

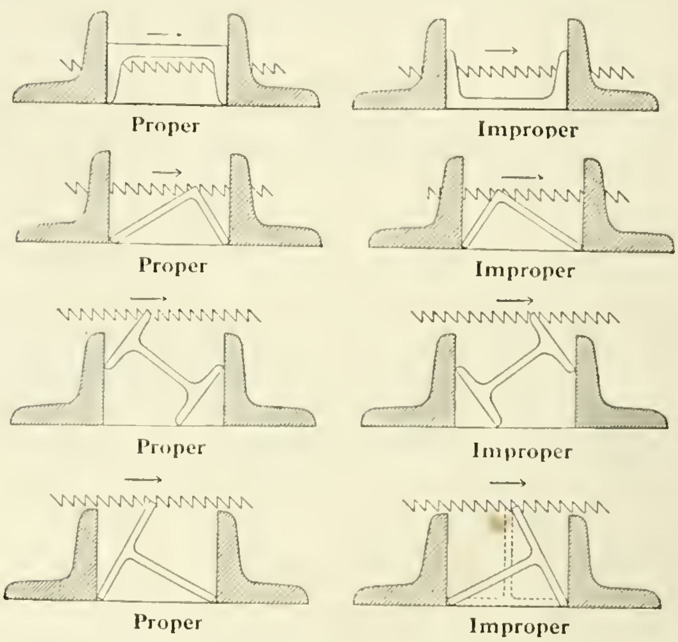


Fig. 3.—Proper and Improper Methods of Holding Various Shapes While Being Cut With a Hack Saw

Cutting speed on rounds of any given material increases as the diameter of the work, and varies in the same proportion as the saw goes through any particular cut. Theoretically, the weight during the progress of each cut should vary directly as the diameter of the work, though this is, of course, impracticable. However, it is essentially practical that, when the time required for any single cut becomes greater than the average time required for cutting that particular class of material, with that particular blade, the weight or pressure on the blade should be increased a few pounds before beginning the next cut.

Increase of pressure to compensate for the wear of the blade is absolutely essential to economy in hack saw work, but it is a factor for which no absolute rule can be given. The most that can be said is, knowing approximately the time in which a certain blade should cut an average specimen of a certain kind and size of material, the weight should be increased by increments from 5 to 10 lb. as often as the time of three successive cuts is above the average. The weight on a heavy gage saw must be increased faster, in proportion to the extra amount of dulled surface or contact area, than for a thinner gage saw, regardless of the difference in weights on the first cut with each. In hack sawing, as in any other form of work, common sense, attention to detail and observations of manufacturers' instructions are great assets.

Micrometer Calipers in Railway Shops

Showing How Output is Improved in Quality and Quantity by the More General Use of Micrometers

BY M. H. WILLIAMS

In 1324 King Edward II of England decreed by statute that, "Three barley-corns round and dry shall be the definition of an inch." The barley-corn days of measuring are long since out of date not only in commercial but also in railway machine shops where the two-foot rule has ceased to be the standard of measurement. Micrometer calipers, now indispensable in railway tool rooms, are coming into more and more common use for general shop work. It may appear at first glance that the refinements possible with micrometers are not necessary for locomotive and car work, which does not as a general rule require the close fitting demanded in some lines of manufacturing. As a means of quick calipering and securing the required degree of accuracy, however, micrometers are invaluable. A large case of instruments used in a modern railway shop is illustrated in

Fig. 1.—Micrometer Calipers Shown in This Case Are Given Out on Checks.

Fig. 1. Common forms of 1-in. outside and adjustable micrometers are shown in Figs. 2 and 3.

Railway shop work being mostly repair work, involves the truing up or re-machining of worn parts and the fitting of new parts. Since it is almost impossible to maintain fixed standards, standard gages can be used only to a limited extent and micrometers will aid in carefully measuring the refinished pieces and new parts with the required degree of accuracy. An accuracy greater than .001 in. is usually unnecessary except possibly for force fits.

Micrometer Sizes Required

Micrometers generally have a range of one inch and different instruments are required for each one-inch range. In order to cover the range of work common to railway shops, it is desirable to provide both outside and inside micrometers for each size up to 12 in. In addition, inside micrometers should be provided for the larger diameters to be measured, such as locomotive cylinders which will require one for each size of cylinder common to the road. For external diameters greater than 12 in., it is advisable to make use of adjustable micrometers having a range equaling the largest piston usually handled. The cost of the instruments mentioned, without duplicates, is about $300. For certain of the more frequently used sizes, it is necessary to provide duplicates that will add to the cost, but the reduced number of spoiled or misfit parts will more than offset the additional expense. Experience in practically all shops where micrometers have been used indicates that workmen will exercise the same care in handling them as a scale or any finished tool and that the cost of upkeep is not a serious consideration. The instru-

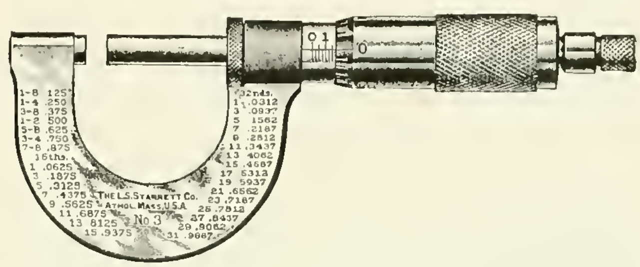


Fig. 2.—Common Type of 1-in. Micrometers.

ments are generally a part of the tool room equipment and given out to any man who may have use for them on tool checks, the same as twist drills, taps, reamers, etc. It is good practice to check each instrument to a standard measuring rod when returned.

Shopmen accustomed to machinists' calipers learn to caliper with micrometers in a few days. Regarding errors in readings, it may be well to consider a concrete example. If it is considered satisfactory to continue piston rods in service where the difference in diameter at any two points does not

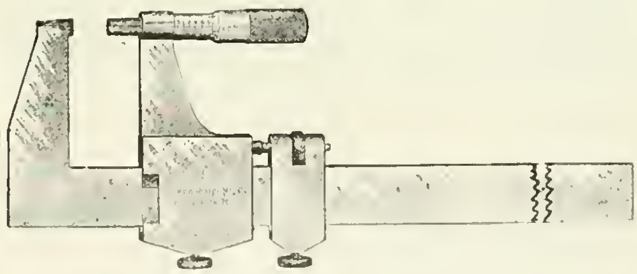


Fig. 3.—Adjustable Micrometer Calipers.

exceed .001 in., measurements with micrometers will show at once if the rod is within these limits and settle definitely the question of repairs. This measurement, also, will tell if the rod is worn to an unsafe limit. The same measurement made with machinists' calipers takes longer and does not give as certain results. Machinists' calipers must be set for each diameter measured, the same as with micrometers, and in each case be compared with a scale or rule in order to determine the differences. Close measurements such as the .001 in. limit in piston rod diameter are impossible to measure with machinists' calipers. Another consideration is the greater ease in reading micrometers.

Axle and Crank Pin Calipering

Axles and crank pins can best be fitted by the use of micrometers. The wheel bores are not exactly to drawing

size owing to wear and other causes and the corresponding parts must be fitted accurately to insure safety. Each .001 in. difference in diameter between a car axle and steel wheel bore varies the mounting pressure from 5 to 10 tons. As an example, assume that similar steel wheels are bored exactly 7 in. One axle, turned to 7.007 in. diameter, will mount at about 70 tons pressure, and another axle, turned to 7.008 in. in diameter, will mount at 5 to 10 tons higher. Wheels and axles are fitted correctly in everyday practice when measured with machinists' calipers and nothing is to be said against the good work that is being done. This close measuring can be done more accurately and quickly, however, by the use of micrometers and the number of misfits will be reduced. The operation of calipering an axle fit in a wheel center is shown in Fig. 4.

In order that the axle and crank pin may be a secure fit in the wheel center, a uniform bearing from end to end is necessary. Likewise, the wheel center should be bored a uniform diameter its entire length. Unless the machines are in an excellent state of repair and the work well done, there are possibilities of the parts being tapered, which is difficult to measure correctly with machinists' calipers. This bad practice may go on for some time if not detected with micrometers and remedied.

Side Rod Brasses

Boring side rod brasses to suitable sizes for running fits on worn crank pins in locomotive repair work is also adaptable

Fig. 4.—Calipering the Bore of a Wheel Center.

to the use of micrometers. It is necessary to measure each pin accurately and bore each brass a definite amount larger than the pin, subject to a reasonable machining tolerance. As an example, suppose good practice indicates that the bore of the brass for pins 5 in. to 6 in. diameter should be not less than .010 in. or more than .015 in. larger than the pin, in order not to cause heating by reason of too tight a fit, or too much lost motion on account of too loose a fit. If the crank pin is exactly 6 in. the brass would be bored between 6.010 in. and 6.015 in. The next crank pin may have more wear and only measure 5.970 in., in which event the brass would be bored between 5.980 in. and 5.985. All the refinements possible with solid limit gages may be obtained with micrometers and any set degree of tolerance quickly measured. For force fits of brasses in rods an allowance of .002 in. to .003 in. is usually made, and this can always be best measured by micrometers.

Crank pins can be measured more quickly with micrometers than with calipers and scale and the sizes set down on a memorandum or form. The operation of measuring new pins is shown in Fig. 5. When boring rod brasses, the inside micrometers can be set quickly and the bore measured with sufficient refinement to insure its coming within required tolerances.

The use of micrometers makes it possible for a designated person to measure all crank pins and similar parts. Where this method is followed memorandums made of the measurements may be given to the various machine operators who will not be called on to leave their machines to go to distant parts of the shop for the purpose of measuring locomotive parts too bulky to take to the machines. This will result in less idle time of machines.

Crank pins are generally found to be worn out of round and tapered when the locomotive comes to shop for repairs.

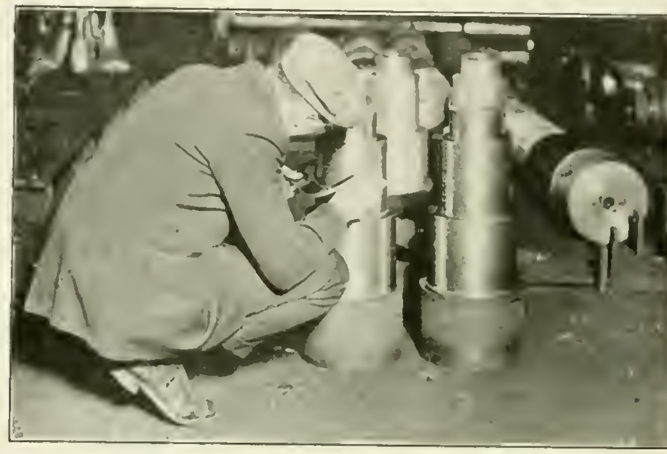


Fig. 5.—Crank Pins Are Calipered and the Dimensions Filled in on a Form.

The amount out of round or taper should be ascertained in order to judge as to the necessity of re-finishing or renewal. By measuring the pins at the necessary points with micrometers the exact amount of wear will be at once detected. Where a limit has been set governing this wear the question of passing or repairing will be at once settled.

Cylinders

For the purpose of measuring the bore of cylinders, inside micrometers as shown in Fig. 6 are used. They have a range

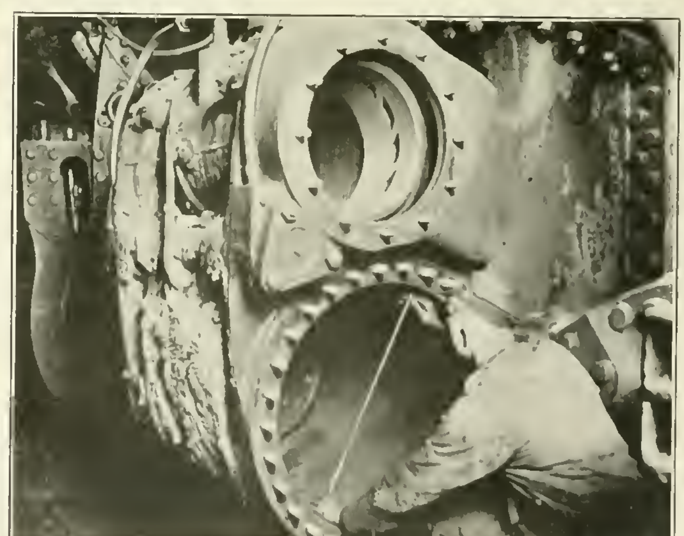


Fig. 6.—Checking the Amount of Cylinder Wear.

of only one inch, which makes it necessary to provide one for each one-inch range in order to measure cylinders handled by any shop. Inside micrometers are also made with an extension piece, by which a considerable range of sizes may be measured with one instrument. This reduces the number of

calipers required, but also introduces chances for error on account of improper setting of the extension piece. The bore of cylinders when new should be measured to ascertain if they are reasonably close to drawing size, as it is a question whether locomotive cylinders can be bored commercially to exact micrometer sizes. However, they may without too great refinement be bored to a limit of 1/64 in. or .016 in. Measurements made with micrometers of the bore at each end will at once check this dimension, and should there be too much of an error steps may be taken to remedy the defects.

When locomotives are repaired the cylinders should be measured in order to determine the wear, or the amount the walls are worn hollow resulting from the travel of the piston head or other causes. On some roads a limit has been set governing this amount, that may be ⅛ in., 3/16 in., etc., depending on conditions. When measured with micrometers, the readings will at once show the amount of variation there may be between different parts of the cylinder and will indicate if reboring is necessary. When turning piston heads, the memorandum taken of the cylinder bores may be made use of by deducting the amount the piston head should be smaller than the cylinder bore.

The disadvantage in measuring cylinders with machinists' calipers is the possibility of error owing to their adjustment being changed while carrying, and also errors due to setting

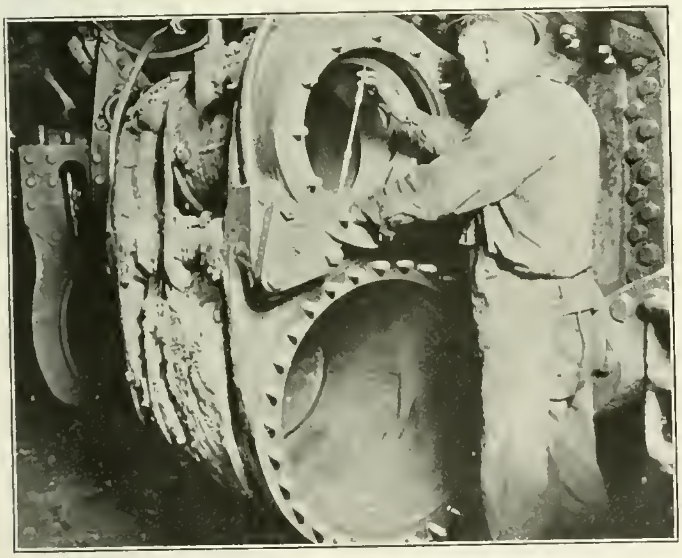


Fig. 7.—Calipering a Valve Chamber Bushing.

one caliper to another. It would be difficult if not impossible to establish limits of variation from the required sizes for turning the piston head on account of the difficulty of reading machinists' calipers closely.

In measuring piston rods and valve rods a few points about the diameters should be considered. Both rods should be of uniform diameter where passing under the rod packing, and unless this is the case, rapid wear of the packing will result. These parts need not be machined to exact diameters, but they should be as close to one size from end to end as possible. By the use of micrometers the rods may be measured at various places and a limit of .004 in. or .005 in. maintained. Where rod diameters are checked with micrometers a decided improvement will be noticed in the reduction of steam leaks.

Piston Valves and Bushings

In order to obtain proper working piston valves it is necessary to make the valve of the correct size in reference to the bore of the bushing into which it works; also, the bushings must be of the right size in order to obtain the desired results. Most valve chambers will be found out of round in the bore for the bushings resulting from the heat of the steam and natural distortion of the casting. By measuring the bore horizontally and 1/3 the way around from the horizontal with inside micrometers, and taking the average of these readings, the average diameter of the cylinder bore is obtained. This size plus the amount the bushing should be larger to allow for a force fit in the cylinder will be the diameter that the bushing should be turned.

Valve bushings are bored larger than the average diameter of the valve chamber bore an amount which will vary with the different diameters of bushings and thickness of walls and may be .005 in. or .007 in. When micrometers are used, experience will soon indicate the exact amount that this should be and bushings may be turned of correct size to insure a proper force fit in the cylinders, avoiding the possibility of steam leaks. When measuring the bore of new bushings or determining the exact amount of wear, inside micrometers may be used as shown in Fig. 7. The diameter of the piston valve bull rings may be measured by a method similar to that explained with reference to piston heads.

Driving Axles and Journals

The journals of driving axles are usually found to be worn out of round, tapered, or both. A slight variation from a perfectly round and uniform diameter does not necessarily call for refinishing; but there is a point between the slightly worn and the excessively irregular axle where refinishing becomes a necessity. This is in some shops governed by a set limit of 1/32 in. or, for easy figuring, .030 in. Measuring the journal with micrometers makes it easy to determine if the limits have been exceeded. As an illustration—if a journal measures 9.860 in. at one place and 9.880 in. at another, showing a difference of .020 in., refinishing would not be considered necessary. Should the readings be 9.870 in. and 9.910 in., making a difference of .040 in., the journal must be refinished.

In the case of a journal having a difference in diameter of only .020 in., a record may be made of the size and made use of when boring the driving box; likewise, the sizes of the journals may be measured after returning for the same purpose. Accurate measuring of the journals after refinishing is in many respects quite important on account of the possibility of their not being regular in size owing to the heavy counterweight on the wheels throwing the lathe out of balance. Improper setting of tool posts also often results in tapered journals. In actual practice micrometers will be found of the greatest value on this work by showing up bad workmanship and lathes not in the proper state of repair or setting.

Driving Boxes

The crown brass of a driving box is somewhat difficult to caliper on account of not being a full half circle, and as a result ordinary calipers cannot be used. In order to overcome this difficulty special three-pronged calipers, as explained in the *Railway Mechanical Engineer* of March, 1919, have been devised. These calipers are illustrated in Fig. 8. Without going into the description too minutely, it may be said that the three prongs, H, H_1 and H_2 are forced outwards by the descent of the taper plunger G, that in turn is controlled by the micrometer head E, the diameter being indicated by the readings on the micrometer dial similar to the method of reading any instrument of this nature. The various springs and appliances shown are for the purpose of taking up lost motion and making the caliper workable.

In practice, journal diameters are measured and sizes recorded on blanks or memorandums, as already explained. The amount the crown brass should be larger than the axle is added to these sizes and the box bored accordingly. During the boring and after its completion the exact bore of the brass is measured with the special calipers shown.

The advantages of this plan as compared with older methods are principally that the diameter of the axle and

driving box may be closely measured and the shell made a definite amount larger than the axle. Where this amount has been carefully worked out and checked, the work of scraping a box to fit the axle may be eliminated, which will result in quite a saving in labor. The three-prong calipers are also useful for checking the accuracy of the rams of boring mills used for boring boxes. These rams are liable to be set out of perpendicular with the mill table and bore larger at one end. A measurement made at both sides of the box will indicate whether the ram is properly set.

Car Wheels and Axles

Micrometers are now used quite extensively for the purpose of measuring the sizes of car axles after being turned. In order that the wheel shall be a safe and satisfactory force fit on the axle the wheel seats should be of a uniform diameter throughout, as in the case of driving wheels. With the more numerous repaired axles it is the general practice to re-turn them to the largest diameter to which they will true up, and as a result each wheel seat is of a different diameter. Measuring by micrometers will be found quicker and more accurate than any other method.

If the difference in diameter from end to end of the wheel seat for steel wheels is kept within .003 in. and for cast iron wheels .005 in., good results will be obtained. For the pur-

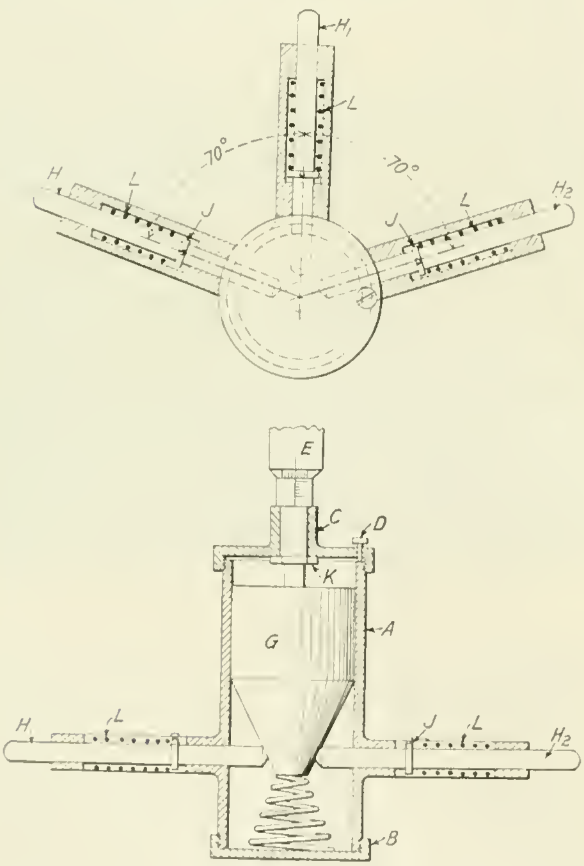


Fig. 8.—Three-Pronged Micrometers for Driving Boxes.

pose of checking these sizes the wheel seats should be measured at ends and in the middle, and the sizes recorded on a memorandum for use when boring the wheels. For steel wheels, the axle should be about .001 in. larger than the bore for each one inch of diameter. That is, for a 7-in. wheel bore, the axle should be about 7.007 in. in diameter. Cast iron wheels would require about double this amount. Inside micrometers are made use of for measuring the bore sizes in order to insure their being correct; also to ascertain if the bore is of one diameter from end to end. This operation will detect any taper and prove the correctness of the size in reference to the axle diameter. An error in turning or boring could not be accurately measured with machinists' calipers. Boring bars having micrometer dials are now largely used for wheel boring and, where wheel seats are measured with micrometers, the sizes for setting the dials on the bar will be at once indicated. As a result, the bar may be quickly and accurately set for as many different sizes as may be required in practice.

The uses for micrometer calipers that have been mentioned can only be considered as representative cases. Where

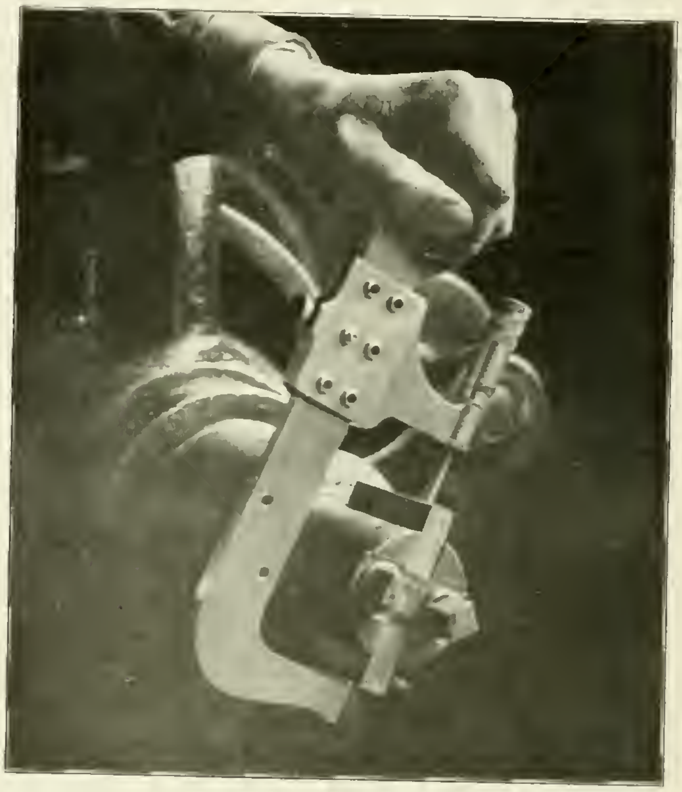


Fig. 9.—Adjustable Outside Micrometers Must Be Used With More Care Than Solid Instruments.

these are once introduced into a shop their use will spread to practically all machining operations where reasonably accurate measurements are required. On account of the ease with which measurements may be made and the accuracy readily obtainable the average workman will prefer these to machinists' calipers, and, when once introduced, there will be difficulty in getting the men to use other forms of measuring devices.

Blind Workers in Cleveland Shops.—Sixty-nine manufacturing operations, principally in the metal-working industries, are now performed successfully by blind workers in Cleveland, according to an article in the *Iron Age*. This city was among the first in the country to see the possibilities in industry for blind artisans, and a start was made in February, 1913, when the Society for the Blind placed one man with the Lake Erie Bolt & Nut Company. He did hand nutting and his pay ranged from 80 cents to $1.25 a day. The movement progressed slowly until war-time conditions created a shortage of labor and since then many openings have been secured. Today there are 81 blind men and women working in 40 different factories. Some of the operations performed include assembling parts, nutting bolts by hand and machine, operating machine tools, packing and sorting. The electrical field has so far revealed more practicable operations than any other, but machine operations have been proved feasible for blind workmen.

The Manufacture of Seamless Steel Tubing*

An Outline of the Method Used in Making Shelby Seamless Steel Tubing from Solid Blooms or Billets

So many seamless steel tubes and flues are used in repairing and maintaining locomotive boilers and for various mechanical purposes that it is believed the following brief description of the modern methods of making seamless tubes will be of general inter-

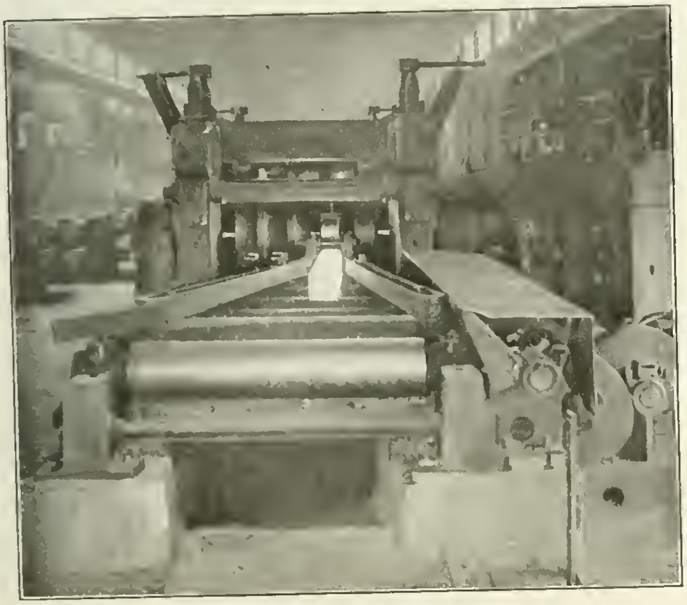


Fig. 1.—Square Billet Entering Bar Mill

est to railway shop men. Satisfactory tubes cannot be made without uniform steel of good quality. This steel is delivered to the heating furnace in blooms of several sizes and weights, 6 to 10 in. square by 11 ft. long and weighing 1,300

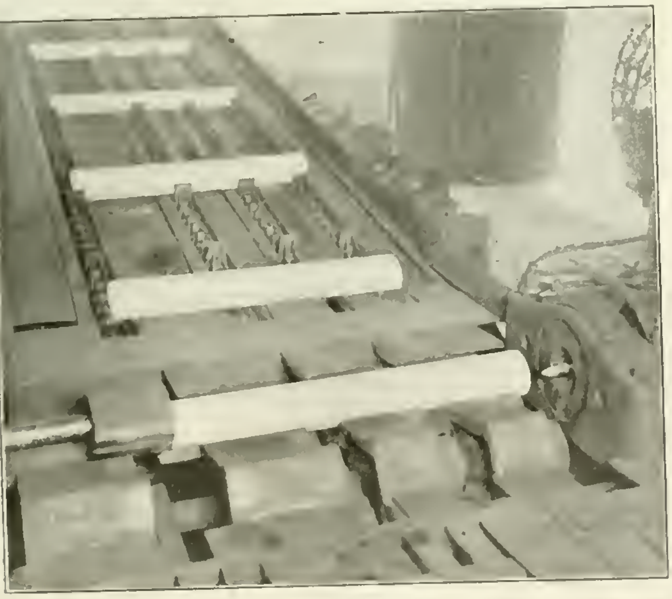


Fig. 2.—Pneumatic Centering Machine in Operation

to 3,750 lb. After the blooms have been carefully inspected for surface defects, and any irregularities chipped off with pneumatic chisels, they are conveyed by a crane to a furnace room where an electrically operated charging mechanism picks them up one by one and places them in a heating furnace.

When the proper temperature for rolling has been reached, the bloom is pulled from the furnace by the long arm of a crane or transfer mechanism and placed upon a small electric buggy; this buggy transfers it to the rolling table of the bar mill (Fig. 1) where it passes through a series of rolls which changes the square bloom into a round bar of smaller size and greater length. Different sizes of round bars are thus rolled according to the size of tubes required to be made from them. Some of the bars are 8 in. in diameter when finished, while others are as small as 3 in. While still at rolling heat, the round bars are cut to different weights (according to the length and wall thickness of the finished tube) by a circular saw, and centered while still hot (Fig 2). They are then allowed to become cold, afterwards being inspected, marked with a die to identify the steel, and sent to the piercing mill.

The bars are now known as billets, or "rounds," and

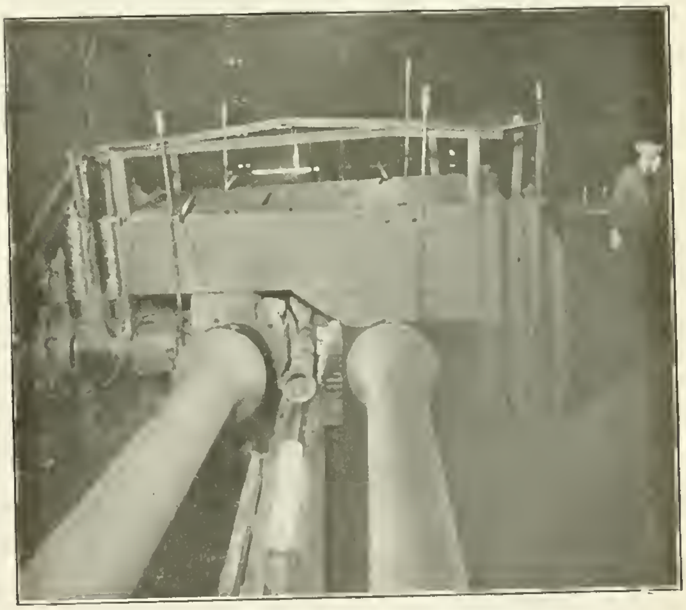


Fig. 3.—Heated Billet Entering Piercing Mill

contain just enough metal for making tubes of the desired length, thickness and diameter, and to compensate for normal losses incident to the manufacture of the tube. After the billets have been centered, inspected and marked, they are placed in a heating furnace of special construction. The bottom of the furnace is inclined, and centered billets of the proper length are fed into the upper and cooler end, from which they roll by gravity to the lower end, where the temperature is high enough to render the steel soft and semi-plastic.

The piercing mill (Fig. 3) is located close to the discharging end of this furnace and the billets are fed into it, centered end foremost. The solid billet, almost white hot, is pushed forward until it is caught by the revolving rolls of the piercing machine which force it over the piercing point of a mandrel. As the billet is forced over this bullet-shaped point by the combined forwarding and rotating action of the heavy revolving rolls (Fig. 4) a dull, grinding sound

*Extracted from a booklet entitled "Shelby Seamless Steel Tubes and Their Making," by the National Tube Company, Pittsburgh, Pa.

is audible. While enormous force is required to operate the piercing machines, there is nothing spectacular about the operation, nor much suggestion of the power required to displace the metal from the center of the hot billet toward the outside. So powerful are the revolving rolls of the piercing machine and so carefully planned is each part of the massive machinery, that the billet is transformed into a tube with apparent ease.

The newly pierced billet is simply a rather rough, thick-walled, seamless tube. It is raw in appearance and not particularly true to size and retains the knurl marks of the piercing rolls on its battered surface. There is positively no weld or seam, however, the round bar of steel having been pierced quite through its length, as a potter would force a pointed rod through a cylindrical mass of moist clay. Because of the thickness of its walls, the pierced billet is short and to change this thickness into length is the next requirement. Accordingly, it is rolled through adjustable rolls and over a mandrel held in the roll groove by a long steel bar, where the wall thickness and diameter are reduced. In this manner the pierced billet is converted into a longer tube with walls of uniform thickness having a fairly smooth finish.

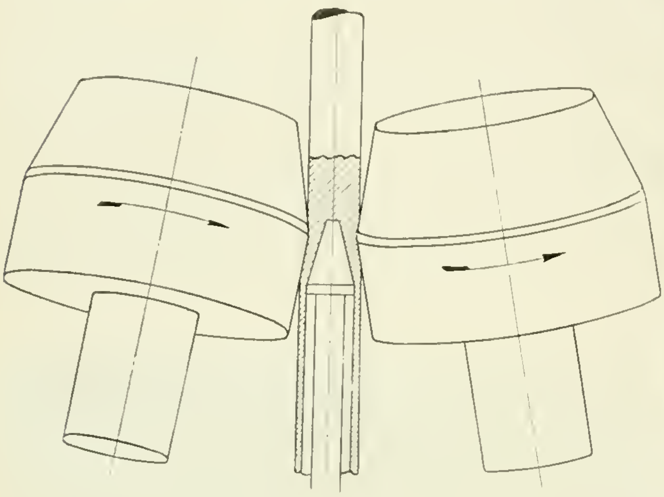


Fig. 4.—Diagram of Piercing Operation

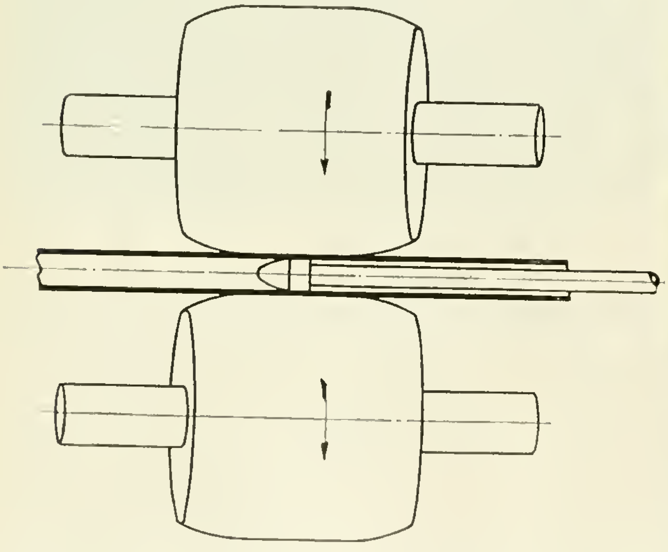


Fig. 5.—Diagram of Reeling Operation

While still at suitable working temperature, the rolled tube passes on through the reeling machine. This is another form of rolling machine, consisting of two heavy rolls of special design (Fig. 5), set with axes askew, which may be adjusted to a thousandth of an inch. As the tubes are fed through these rolls any mill-scale is removed and they are given a smooth, burnished surface, the outside diameter of the tube being corrected to some extent.

From the reeling machine, the tubes pass to the sizing or finishing rolls (Fig. 6) which give the exact outside diameter required. From the finishing rolls, the tubes travel to an inclined cooling table (Fig. 7) up which they slowly roll, and after being sorted and inspected are dropped into racks, ready for removal by electric cranes. The electric cranes transfer the hot finished tubes to cutting-off machines where the rough ends are trimmed from the tubes and the tubes are cut to proper length. Any slight straightening necessary is then done, the tubes thoroughly inspected (if boiler tubes, a hydrostatic pressure test is also applied), then stencilled, put in stock or sent to the shipping room.

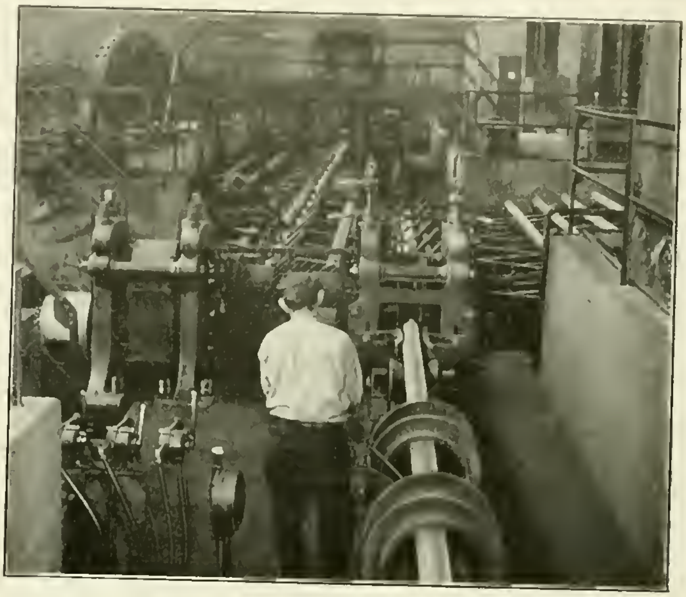


Fig. 6.—Reheated Tubes In Sizing Roll

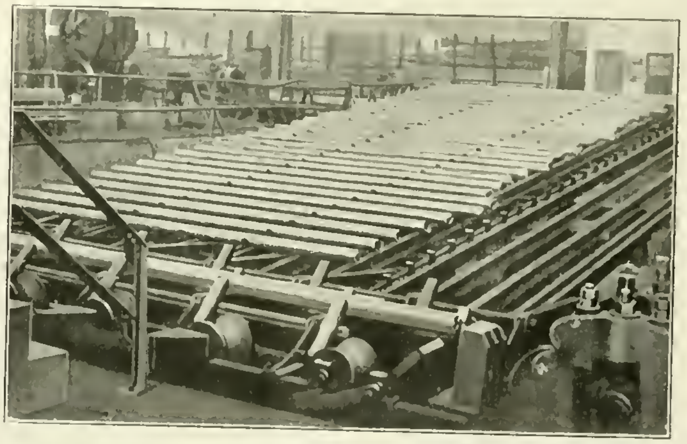


Fig. 7.—Inclined Cooling Table

The engineers' committee of the Fuel Administration issued a report which contained figures showing the effect of lack of cars on the cost of mining coal. This information is being circulated in a diagram published by the National Coal Association and is reproduced in some of the leading coal trade journals.

Master Blacksmiths Meet at Detroit

The Subjects Most Thoroughly Discussed Were Frame Repairing, Spring Making and Reclamation

Over one hundred members of the International Railroad Master Blacksmiths' Association were in attendance at the twenty-sixth annual convention, which was held at the Hotel Statler, Detroit, Mich., August 17, 18 and 19. Following the customary opening exercises the president's address was delivered by John Carruthers (D. M. & N.).

President Carruthers' Address

In opening his address President Carruthers referred to the fact that at the last convention, Birmingham, Ala., was chosen by ballot as the place for this year's meeting and explained to the members that inability to secure suitable hotel accommodations made it necessary to seek another meeting place. Detroit was chosen because, next to Birmingham, it had received the largest number of votes.

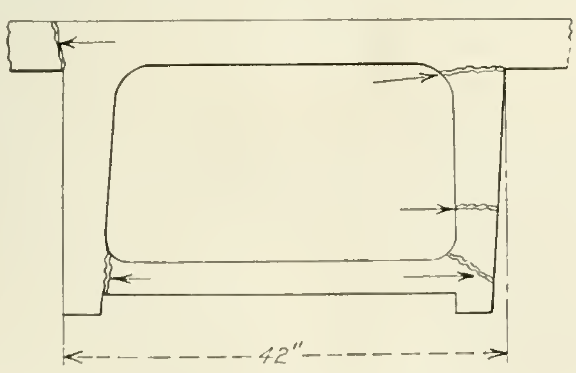
Speaking of the importance of the work of the Association, President Carruthers said in part: "Never before in the history of railroading have we felt so much in need of the newest and most improved methods to obtain better service and the greatest possible production. Let us have the co-operation of all the members to the end that the largest measure of good may be brought out of our deliberation both for ourselves as individuals and the companies we represent. It is up to the supervisory forces to untangle the mesh in which the railroads have been returned to their owners.

FRAME MAKING AND REPAIRING

By F. F. HOEFFLE
Louisville & Nashville

Wrought iron for new frames has been displaced by steel and the steel frame has been developed to better design and efficiency. But the modern well-designed frame breaks and failures often take place at strong sections where least expected. Our problem is, therefore, the repairing of frames.

The Thermit weld has brought about wonderful results in keeping power in service, yet there are conditions brought about by the Thermit weld which have not been overcome, such as holding in abeyance expansion and contraction. Where numerous Thermit welds have been made on frames in roundhouses and the welds are very close together, one is led to believe that these numerous welds were caused by not holding expansion and contraction in submission.



Welds of Frame Members Which Are Bound Together, thus Preventing Freedom of Expansion and Construction

When a Thermit weld is made on a frame at a point where two or three members are bound together, the expansion and contraction cannot take place freely; hence the weld is liable to cause a strained condition at another point. Such portions of frames are seen with a number of welds, no matter how carefully preparations were made to overcome this faulty condition. A weld which is capable of adjusting itself with no danger of causing a stress at another point has proven to be a good proposition.

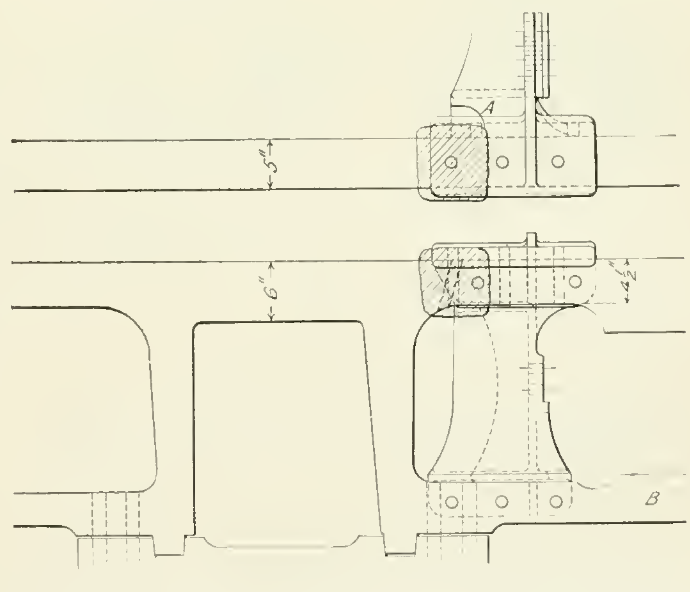
When an engine is brought into the South Louisville shops of the Louisville & Nashville for a general overhauling and it is necessary for the boiler to be dismantled, if the frames are in bad condition they are turned over to the smithing department and at once the entire set of frames is placed in a soaking pit and heated thoroughly, then allowed to cool. They are then brought into the blacksmith shop, all Thermit welds removed and the frames put in first class condition.

This practice has given the results we looked for, and is evidence that the anvil is the proper place to repair a frame.

The oxy-acetylene process is used to great advantage for such work as cutting and the filling of surface defects; but where a frame is broken its use is not considered a good proposition.

By G. W. KELLEY
Central Railroad of New Jersey

The successful use of the electric, oxy-acetylene and Thermit process for welding depends largely on the operator, who must be an enthusiast and must be trained as an apprentice before he can become an expert and successful operator.



Charcoal Was Used to Heat the Upper and Lower Frame Rails for Expansion in Making This Thermit Weld

The use of these different methods of welding has produced wonderful results. However, in their experimental period, failures were made by many who did not understand the nature of the various metals, or did not allow for the proper expansion to take care of the contraction. The sketch will illustrate how much expansion is sometimes necessary where it has required 115 lb. or more of Thermit to make an engine frame weld.

The cast steel cross brace was cut out at A to permit the wax collar and mould to be applied. This was also necessary to allow the top rail of the frame to expand. We used three charcoal containers to get expansion: one on the lower

frame rail at *B* and the other two at the opposite sides of the weld. While the mould was drying and preheating the expansion was also taking place. When the proper expansion was obtained, which was 9/32 in., the weld was made. When the frame was cold the tram was perfect. The cross brace was then electric welded by the metallic electrode process. We prefer charcoal to an oil burner for obtaining expansion because with the oil burner the contraction in the frame takes place much faster than in the weld. When the weld is made we let the charcoal remain in the metal containers and all frame members contract together. No more attention is required until the frame is cold, as we arrange to make the weld at the last working hours of the day.

Discussion

The discussion of this subject was confined practically to the application of the various welding processes and a variety of methods which have been used successfully with each process were brought out. The discussion indicated that at least among those taking part in it the Thermit process is still most generally used in welding complete fractures of frame members. In some cases this process has been adopted to the exclusion of the others except for building up worn surfaces. It was evident, however, that both the gas and electric welding processes are being used for heavy frame welding with complete success. The electric welding process is meeting with favor for this work because of the small amount of contraction which must be allowed for, thus simplifying the preparation for the welds. One of the members stated that with no allowance for contraction whatever where the electric process was used the effect of contraction would be no greater than with Thermit, oil or gas welds where the most careful preparation had been made. Excellent results have been obtained with the gas welding process employing the usual run of operators obtainable under the national agreement. Several members, however, dwelt on the necessity of more care in the training of operators if the electric and gas welding processes were to continue to advance. The practice of requiring welders to turn in test welds periodically, to be pulled in the test machine, is being followed by some master blacksmiths with excellent results. The welders are rated according to the strength of the welds relative to the strength of the unwelded material.

The national agreement, in making welding a preferred job in each craft, has tended to destroy permanency of employment on these jobs. The men consider the work temporary, often leaving it to return to the regular work of their trades before they have been at it long enough to become thoroughly skilled operators and the company suffers in consequence.

SPRING MAKING AND REPAIRS

By J. W. RILEY
Lehigh Valley

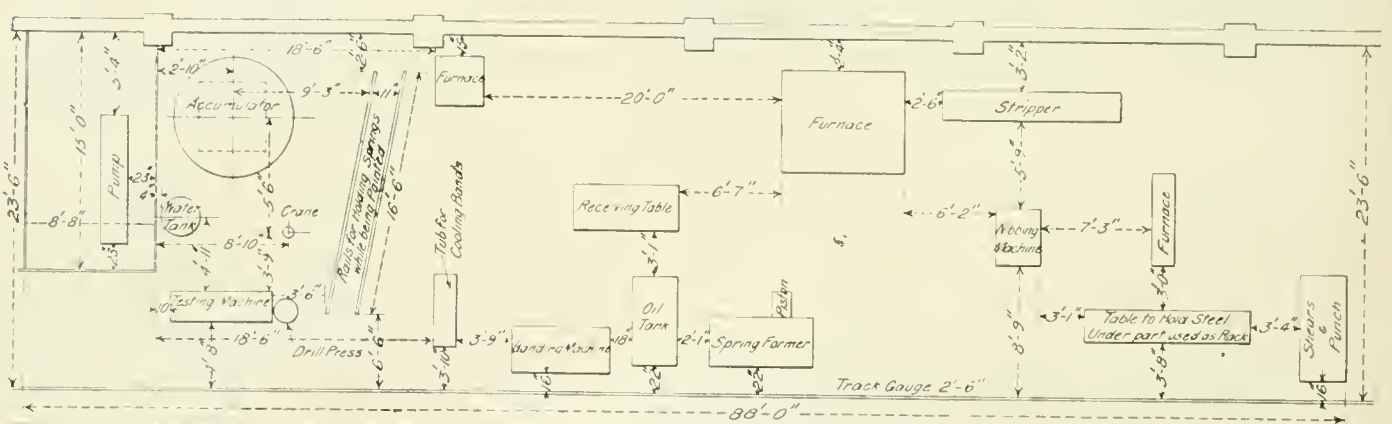
In 1915 the management suggested that we submit a list of machinery that would be required for making and repairing of springs for the Lehigh Valley System. After going over the advantages of such a plant a decision was finally reached in favor of purchasing the machinery. The following is a list of machinery installed in the smith shop, occupying a floor space of 88 ft. by 22 ft. The arrangement, which is shown in the drawing, is very convenient.

Machines Installed in Lehigh Valley Spring Plant:

- Hydraulic steam pump.
- Hydraulic accumulator.
- Combination punch and shears.
- Combination nibber and trimmer.
- Hydraulic band stripper.
- Hydraulic bander with assembling table.
- Universal elliptic spring former.
- Oil tank with water jacket.
- Single fitting or forming furnace.
- Furnace for nibber and punch.
- Banding furnace.
- Thirty-five ton testing machine.
- Small air drill for drilling bands

Before starting in the spring work I visited a number of spring plants and in most places found that they were equipped with rolls for forming. These were not much in use, however, and the springs were being formed by tongs and hand hammers. This method is slow, is hard work for the spring maker and only an expert can do a good job. The tongs and hammer do not set the plates so they have a full surface bearing, strains are set up in spots, causing the leaves to warp when cooled in the oil, and it is necessary to overheat heavy plates to be able to form them. Over-heating the steel is one of the greatest causes of broken springs. Another effect of over-heating is the reduction in the weight of the steel. A spring heated and formed about twenty-five times will be reduced about one leaf on a twenty-five leaf spring; the higher the temperature the greater is the reduction.

As a result I developed a universal elliptic spring former, which performed the work so successfully that the former was placed on the market and is now in use in several spring plants. With this the leaves are scientifically formed and any twist that may be in the steel is taken out. It is universal because it is ready at all times to receive leaves of any radius, length, width or thickness. With this machine the fitter requires no assistance from the heater, who may devote his entire time to heating and passing out the leaves. There is no need of heating the steel over 1,500 deg., F., as the machine will properly set the leaves at that temperature and it takes but an instant from the furnace to the oil. A master plate is used in setting the main plate and the balance of the



Layout of the Lehigh Valley Spring Shops

spring leaves are formed by pressing the hot leaf against the cold leaf. One stroke of the machine forms the leaf and gives it the desired amount of snap.

We do not taper the leaves. They are left square on the ends as they come from the shears. We use loose gib plates; some are cast steel, while others are formed in dies and made from scrap steel.

When we started repairing purchased springs we had eight men working 10 hours and a lot of overtime. After running a large percentage of the springs through the former the work kept decreasing until in a year's time we only required six men. Six months later only four men were working 10 hours and at present we have four men working 9 hours. These men do all the making and repairing for the Lehigh Valley System. The equipment consists of 1,000 locomotives, the tenders of which have elliptic truck springs, 700 coaches and 475 cabooses which have elliptic springs. These four men do not make bands. The bands are made in the forging machines and at the forge.

The records of one shop that had been using the tongs for fitting show an average of 36 trailer truck springs repaired per month. After the former was installed and a number of these springs run through the former the repairs to these trailer springs was reduced to six per month.

We use the flash temper. After using this method of tempering for four years I do not want to change to any other.

Discussion

The discussion centered around the practicability of making and repairing springs in railroad shops. The opinions expressed on this subject were generally in favor of this practice rather than purchasing manufactured springs and having them maintained either by the manufacturer or in the railroad shop. Where this practice has been adopted the results obtained have been substantially the same as those indicated by Mr. Riley in his paper.

The practice on most of the railroads whose representatives took part in the discussion is to repair springs on store department orders, replacement being made from store stock instead of directly from the blacksmith shop. The hammer test is generally depended on in large shops to detect broken leaves. This is applied either directly in the erecting shop or in a blacksmith shop. In some cases all springs are removed to the blacksmith shop, where those which pass the hammer test are placed under the spring testing machine to determine the load capacity before being passed as suitable for further service.

One case was mentioned where considerable trouble had been experienced from repeated failures of the short leaves on a class of heavy trailer springs weighing 875 lb. each. The failures in these leaves occurred at the edges of the band. It was finally decided that the trouble was due to the broad bearing of the band against these leaves, which destroyed their flexibility and caused a concentration of load at the edges of the band. The trouble was overcome by rounding off the edges of the upper surface of the bottom side of the band, thus producing a crown bearing for the short leaves, which permitted them to deflect throughout their length.

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Secretary-Treasurer

RECLAIMING SCRAP MATERIAL

By F. B. NIELSEN
Oregon Short Line

In railroad shops of considerable size, in order to obtain best results in reclaiming scrap material, one of the first steps to be taken is the formation of a scrap committee. This committee should consist of representatives of the following departments: motive power, car, bridge and building, maintenance of way, and store department, accompanied by others qualified to pass judgment on the serviceable and scrap material. This committee should report to the superintendent of motive power at least once every week.

A committee of this kind has been established at the main shops of the Oregon Short Line at Pocatello, Idaho. It is composed of the superintendent of shops, engineer of the maintenance of way department, general foreman of the store department, general foreman of the car department and one or two foremen from the various departments who are invited to accompany the committee each week. This committee visits the scrap dock, taking out any serviceable material that may be used. Each case is taken up as an item on the minutes and given a number. A copy of the minutes of the meeting each week is sent to the head of each department and those responsible in each department are required to make a report to the chairman of the committee, as to why this material was scrapped

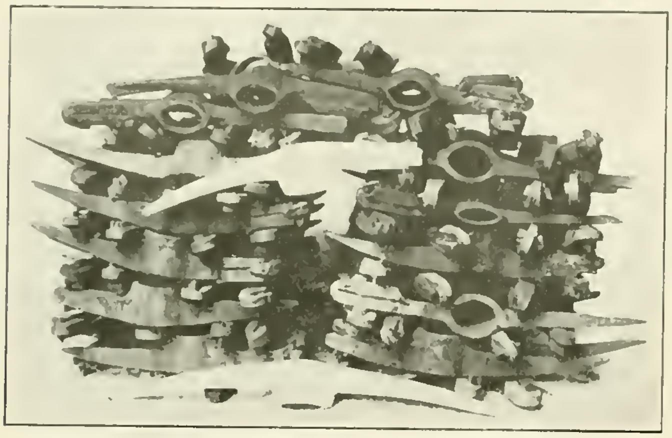
A general inspection of the yards is made once each month, taking in all buildings, to see what material is lying around that is not being used. This is also reported.

This committee has proved very successful in reducing the amount of serviceable material found in the scrap pile and cases where such material is scrapped are constantly becoming more infrequent.

On the Oregon Short Line we have a re-rolling mill, and reclaim practically all small size iron, from ½-in. to 1¼-in. round, and from ⅜-in. by 1½-in. to ¾-in. by 2¼-in. All washers are made from scrap sheets and plates accumulated at the scrap dock. About seventy per cent of all scrap spikes

are reclaimed. These spikes are straightened in an air-operated machine constructed especially for this purpose. After being straightened they are put in a rattler to be polished. All second-hand bolts are reclaimed by cutting off and re-threading.

I have observed, from the different material removed from foreign line equipment that is coming into the welding room



Worn Picks Prepared for Reclamation by Welding on Stock Drawn Out from Scrap Mauls

of our shop, that proper attention is not given to oxy-acetylene welding.

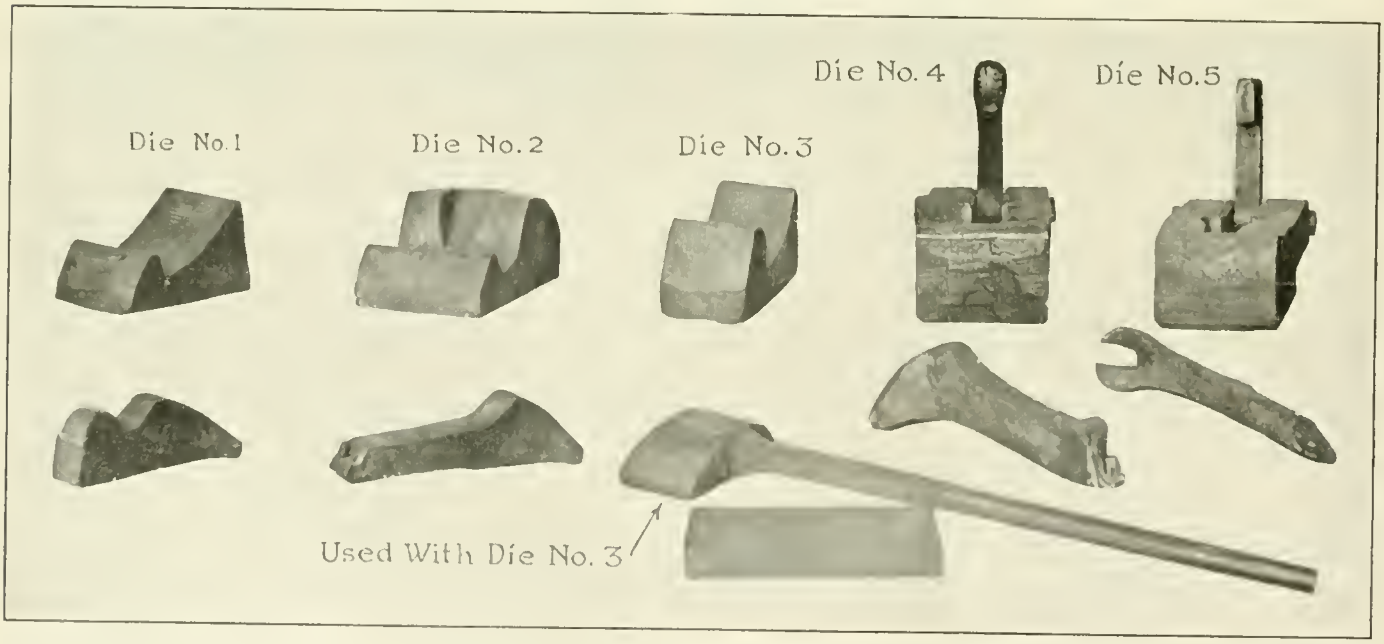
Our practice is to give each welder a piece of steel 1½ in. square and 14 in. long all from the same bar. This piece is cut in the center, welded and then broken in a tensile testing machine. When we first began these tests the lowest record efficiency. I feel sure that if this method were followed there would be no objection by the American Railroad Association to the reclamation of some of the material to which they now object.

Frogs and switch points are reclaimed and fair success has been attained in reclaiming manganese steel frogs and switch points. All track tools on the system are sent to Pocatello for repairs. When picks become too short we draw out some of the scrap spike mauls, which are then welded into the picks, making them of standard lengths. Claw bars are reclaimed by forging out the claw end from scrap tire steel and welding to the old bar. One of the illustrations shows the steam hammer dies employed in forming the claw ends.

Coil springs that are standard are reset and scrap springs are made into drift pins, small lining bars, jack bars, etc. The tamping and the spade ends of tamping bars are made from scrap coil springs. These are welded to the old bar. Scrap tire steel is drawn out for track lining bars, pinch bars, piston keys, spring hanger gibs, coal picks and similar pieces.

We have recently received a number of hollow heat treated locomotive axles. When obsolete they are reclaimed for making guides, counterbalance sheets, follower plates, dry pipe rings and dies for forging machines. We also reclaim piston heads with Tobin bronze. Main rods that are worn from lack of oil are also reclaimed with the same process.

Lathe tools for wheel lathes are drawn out of scrap tire steel and high speed steel is welded on by the oxy-acetylene process. Many shops do not seem to have good results in reclaiming these tools, and I do not think it is practical to make small tools by this process. Another important thing in the reclaiming of all material sometimes overlooked in the cutting and dressing of high speed tools, is that all pieces cut off and all broken small tools, such as drills, reamers, etc., should



Steam Hammer Dies for Forming Claw Bar Ends. Die No. 1 Draws the End and Forms the Heel; Die No. 2 Shapes the End; Die No. 3, with Flatter, Finishes the Heel and Curves the End; Die No. 4 Countersinks for the Claws; Punch Die No. 5 Forms the Claws

of tensile strength was 67 per cent of the original strength and the highest 83.8 per cent of the original strength, with a reduction of area of 8 per cent and practically no elongation. The last test made in April, 1920, by the same welders and the same method showed the lowest record of tensile strength to be 85.7 per cent and the highest 99.7 per cent of the original test, with an elongation of 6.5 per cent.

Through information obtained by this method the best welders are selected for reclaiming such material as couplers, frame work, and other work requiring a high percentage of efficiency.

be saved and turned over to the store department for reclaiming.

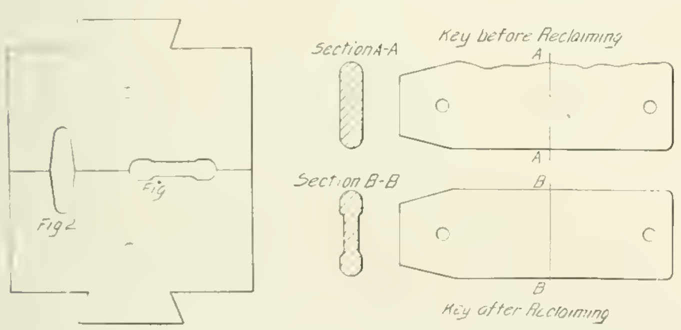
By J. HARKIN
Southern Pacific

A reclaiming plant should be located conveniently to the segregating point of all scrap material and within easy access to the main shops and store. In order to operate a reclaiming plant economically it will be necessary first to determine the kind and the quantity of material of various kinds desired

to be reclaimed; when this has been decided upon there should then be installed the necessary machinery for reclaiming the various articles with the least possible expense.

At the Southern Pacific shops at Sacramento, Cal., brake shoe keys are being made from ¾-in. or ⅞-in. scrap bolts or bars. Brake staffs for flat cars can be made from discarded brake staffs from box cars. We make split keys, angle iron for ladders on box cars, washer plates and door plates from scrap tubes. We use scrap coil springs for making the various styles of bars, packing hooks and packing irons used by the maintenance of way department and car inspectors; these bars vary in size from ⅜-in. round to 1⅜-in. round and from one foot to five feet in length. All our claw bars, lining bars and tamping bar ends are made from scrap tires, as well as headers and dies used on our small size bolt and forging machines. We have been using scrap tire steel for making superheater unit bolts for locomotives with very good success; also we have for some time past been making the flat drills used by the maintenance of way department from scrap files. These drills are ordered in lots of 250 and vary in size from ¾-in. to 1⅛-in. and are usually 6 in. long. We have had very good service from these drills.

We reclaim all scrap 40-ton axles by working them over to 30-ton axles; while the 50-ton axles are reforged to a standard 40-ton axle. These axles are usually reclaimed in a



Die Blocks Used for Reclaiming Worn Draft Keys—Norfolk & Western

forging machine suitable for such work, but they are also reclaimed with tools made for the purpose under a steam hammer.

There are usually a number of articles such as handholds, brake rods, couplers, coupler yokes, bolts, nuts, track spikes, switch points, etc., that find their way to the scrap dock from various points on the line. Such material is inspected and much of it reclaimed, or, as some would prefer to say, repaired, and turned over to the store department and carried in stock.

While we give the closest attention to the reclaiming of material at our scrap dock, such as is mentioned above, our greatest success in reclaiming scrap has been accomplished in the rolling mills, where we are using over 5,000,000 lb. per month by rolling it into standard sizes of bar iron from ⅜-in. round to 3½-in. round, and flat bars from ⅛-in. by ½ in. to 1 in. by 12 in. We also manufacture tie plates and angle bars, using material taken from the scrap pile.

By P. T. LAVENDER
Norfolk & Western

The drawing shows a set of hammer dies which have been developed for reclaiming worn draft keys. These dies are very simple to make and can be used in any steam hammer.

We first put the bent and worn draft keys in a furnace and when properly heated straighten them under a hammer. They are then placed in the die shown at the left of the die blocks, which spreads them ¼-in. above size. Then they are placed in the die at the right, which brings them to the size required.

When the operation is completed the key is just as serviceable as one made from new bar stock. We work keys over two and three times before they are sent to the scrap pile.

By T. F. BUCKLEY
Delaware, Lackawanna & Western

Reclamation of scrap materials on railroads has been going on for many years, but lately, due to the high cost as well as the shortage of new material, more attention has been paid to this subject than ever before. Yet it must be recognized that wages have advanced and consequently too much time may be put on many articles, making them more expensive to reclaim than to provide wholly new parts.

Of course scrap is found everywhere from one end to the other of the road and reclamation should take place at a central point, preferably at the company's most important shops where facilities for handling it may be provided. Competent inspectors who thoroughly understand railroad material and its uses should supervise the sorting and reclamation.

Material to be reclaimed should be taken to the main shops, where the necessary steam hammers, shears, and such other facilities as the process requires are located.

Draw-head castings, steel couplers, bolsters and other parts of locomotives and cars slightly cracked but otherwise in good condition should be sent to the shops and have the electric or acetylene torch applied to them. Reclamation by welding has saved thousands of dollars within the past few years.

It may prove economical to provide an auxiliary preparation plant near the scrap dock, where materials can be partially prepared as they are sorted, thus minimizing the cost of handling. This plant should be equipped with bolt threading machines for re-threading bolts, rods, etc., with a nut tapper for retapping old nuts; with punch and shears for making washers and keys. A reclaiming roll for rolling up to 2-in. round and 1-in. by 4-in. flat can profitably be used; there should also be a steam hammer for cutting, straightening and hammering the heavier materials such as scrap axles; for reforming and hammered into round bars 3-in. to 5-in. rounds and making hammered iron into usable sizes, there should be furnace equipments in connection with the hammers and rolls. A plant of this kind can be made to pay for itself in a very short time under favorable circumstances.

In addition to being well versed in the quality of railroad material those in charge of the work should know whether or not it would pay to reclaim in special cases as they arise. Many articles may be reclaimed economically today, but not a month from now. So it is true that as reclamation is a good thing the returns gained thereby are large or small according to the intelligence used in carrying it on.

Discussion

The discussion developed the fact that others are following the practice of reclaiming worn piston heads by building up with Tobin bronze, which Mr. Nielsen mentioned in his paper. It is considered practical to reclaim pistons in this way with a maximum wear up to ¼-in. thick at the heaviest part and extending around approximately one-half the circumference of the piston. This practice has also been used in reclaiming worn slide valves, and in both cases experience has indicated that the reclaimed parts remain in service without further repairs much longer than do new parts.

In answer to a question as to the advisability of manufacturing superheater unit bolts, Mr. Harkin stated that these bolts would not be made in the shop if they could be purchased, but that the use of tire steel, annealed after the bolts had been forged, has been successful. In using tires for the manufacture of parts requiring strength the practice of turning off the flange, and if the tires include inside retaining flanges, cutting these off with the acetylene torch was advocated. An attempt to forge the tire with the flanges left on usually results in the flange turning over and forming a seam in the material.

The greater part of the discussion was devoted to the reclamation of axles. Two general methods are being followed, one in which the whole axle is reworked, the body being drawn out and the journals upset, to reduce the reclaimed axle to the next capacity below that of its original state; and the other reworking the end of the axle only to restore them to the original capacity. The second method requires the addition of material to the ends of the axle. This is being taken care of at the Beech Grove shops of the Big Four by turning off the collar at the ends of the journal, heating the axle and upsetting the journal by forcing a wide angle cone punch into the ends of the axle and then jump welding a plug provided with stock for the collar into the cavity. Some of the members considered this practice open to objection because each time the ends of the axle are upset the distance between the fillets at the wheel seat ends of the journals on the opposite ends of the axle is reduced from 1/4-in. to 1/2-in.

The details of the first method as applied on the Santa Fe were described by George Fraser. The bodies of the axles are first swedged down to increase the length, one half of the axle being heated at a time. The journal collars are then broken down, the ends heated a few inches beyond the wheel seat and upset in a forging machine. The axle is not gripped in the dies but is held against an independent back stop which determines the length. The finished forging has one-half inch of stock for finishing to the required size for the next capacity lower than the original and the size of the body is larger than required by the M. C. B. rules. These axles provide an opportunity for using up wheels with oversize bore.

A question was raised as to the advisability of reclaiming scrap axles because of the uncertainty as to the condition of the material after the axle had been in service long enough to be worn beyond the limit for the original capacity. Some of the members considered the practice inadvisable, unless the material in the axle were reworked throughout its entire length.

Association Business

A Committee on Amalgamation with the American Railroad Association, Section III—Mechanical, appointed subsequent to last year's convention, presented a brief report outlining the probable status of the association should it amalgamate with Section III—Mechanical. The association authorized the committee to conduct the necessary negotiations with a view to accepting the invitation of Section III—Mechanical—of the American Railroad Association to become a member of the American Railroad Association—Section III—Mechanical—subject to a vote of approval at the next convention.

The secretary-treasurer reported a total membership of 245 at the close of the year and 21 new members were received during the convention. The balance in the treasury showed an increase of $141.58 last year to $227.82 this year. In order to continue to meet the increased cost of conducting the affairs of the association, however, the dues for the coming year were increased from $4.00 to $5.00 a year.

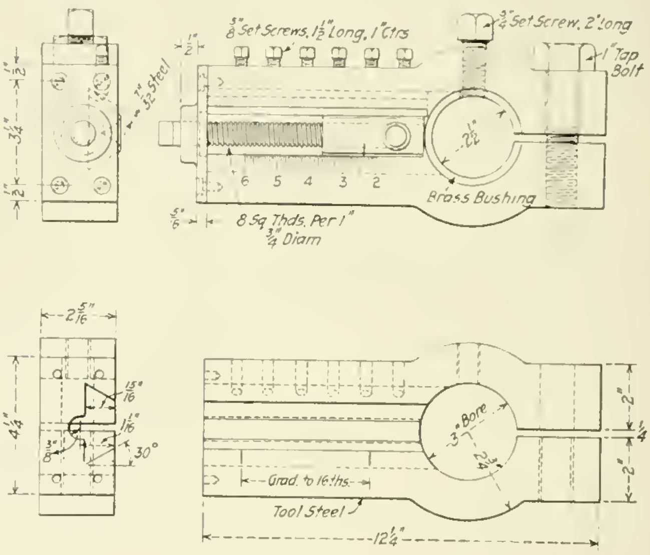
The following officers were elected to serve for the coming year: president, Joseph Grine, (New York Central); first vice-president, George Hutton, (New York Central); and second vice-president, S. Lewis, (Canadian National). W. J. Mayer (Michigan Central), who was first vice-president during the past year, was elected to the presidency; but owing to the demands that he be made secretary-treasurer to succeed A. L. Woodworth, who asked to be retired following a continuous service in this office of 22 years, Mr. Mayer resigned the presidency to accept the office of secretary-treasurer.

Montreal, Quebec, was unanimously chosen as the place for the next convention, with the provision, however, that the executive committee be empowered to make other arrangements should the best interest of the Association so require.

ADJUSTABLE CENTER BLOCKS FOR CRANK SHAFTS

By J. K. BLAIR
Norfolk & Western, Roanoke, Va.

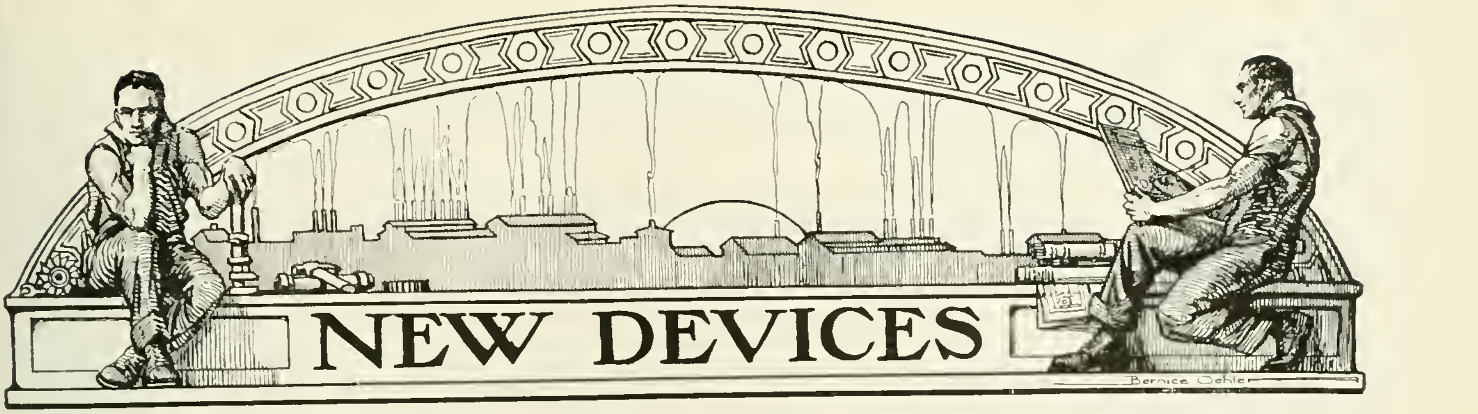
In turning crank shaft bearings, it is usually necessary to make center blocks to accommodate every different diameter of end bearing and crank throw. As this is laborious and costly, the device illustrated herewith will be found a useful adjunct in the machine shop. It has been found very handy for turning the wrist bearing on various styles of stoker cranks and similar work. The block which carries the



A Useful Device for Stoker Repairs

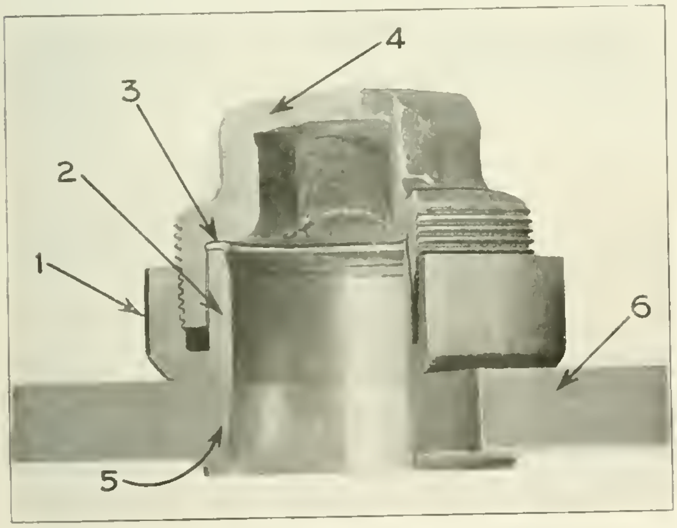
adjustable center is bored large enough to accommodate the end bearing on the crank shaft, the end being split and a set screw placed in the side to hold the parts securely. In clamping smaller sizes, the hole is bushed. The sliding center works in a dove-tailed groove fitted with an adjustable gib and is moved back and forth by the screw as shown. A scale on the block indicates the offset between the centers of the bearings.

British Link Truing Device



Safety Locomotive Boiler Washout Plug

A WASHOUT PLUG of new design has been placed on the market by the Housley Flue Connection Corporation, Indianapolis, Ind. This plug has been in use for some time and has been thoroughly tested under service conditions. For test purposes a pressure of 1,800 lb. cold water has been applied and it is reported that the plug withstood the pressure without leaking. The plugs used in the test were not especially designed, but were taken from the stock room.



Housley Safety Washout Plug

The construction of the plug is indicated in the cross-sectional view illustrated. The sleeve *1*, which is installed in the boiler sheet, is rolled in on a three-degree taper and remains permanently in place, special rolls and expanders being provided for this purpose. A particular feature of the plug is the protecting wall *2*, which safeguards the threads against smashing or distortion caused by washing rods and hose nozzle. It also prevents water from touching the threads, allowing no scale, rust or sediment of any kind to form. The top of the protecting wall is the seating face for the gasket *3*. This gasket fits snugly in the top of the plug cap in a special groove and does not drop out when the cap is removed. It is this gasket that solves the problem of leaky plugs, because when the plug cap is screwed down tight on a soft copper gasket leaks are practically impossible.

The plug cap *4* is the only part that is removed for a washout and in replacing, the caps cannot be cross-threaded because the protecting wall acts as a pilot. The nipple *5* or the lower part of the sleeve which fits in the boiler is rolled in the sheet on a three-degree taper, the larger end of the hole being in the boiler; *6* is the boiler sheet. Owing to the absence of scale and rust and the good condition of the threads, it is stated that one man can readily remove these plugs from boilers.

The Germ Process of Compounding Oils

PAPERS on the Theory and Practice of Lubrication by Henry M. Wells and James E. Southcombe, of the Henry Wells Oil Company, London, Eng., were read in Pittsburgh recently. The authors explain the rationale of the superior lubricating properties of fatty oils and of oils compounded with fatty oils over "straight" mineral oils (i. e. mineral oils not compounded). The property has hitherto been mentioned by various observers but left in that position. This led to an examination of the principles on which lubrication depends. It was demonstrated that liquids which wet solid surfaces are lubricants, while liquids which do not wet them are not lubricants; that one property which differentiates them is largely that of capillarity, or interfacial tension; that the fatty acids in fatty oils perform the functions of lubrication and not the fatty oil per se. It was also found that if the fatty acid be extracted from a fatty oil it is little if any better than a mineral oil as a lubricant and that if a fatty acid in small quantities be added to mineral oils, their lubricating properties are very appreciably enhanced. Results in the laboratory were confirmed by several independent authorities.

On the practical side, the authors cite many examples where fatty oils, or oils compounded with fatty oils, have been entirely and successfully replaced in actual practice by Germ Process oils for lubrication of steam engines, gas and oil engines and many types of mechanism. Results of trials of marine engine oil on a large scale over 18 months, by the British Admiralty were cited. Germ Process oils are cheaper than fatty compounded oils, and are suitable for the heaviest work in all climates.

The title "Germ Process" selected by the authors is purely arbitrary—chiefly from the fact that hitherto engineers and chemists have had an aversion for the word "acid" connected with any oil. The authors not only dissipated that

fear by proving it was grounded on a complete misapprehension of its functions, but proved that the feared fatty acid was a very useful ally when its functions are understood and controlled, which, it is stated, the Germ Process ensures. The claim is made that by this method of preparation superior oils can be obtained at a fraction over the cost of mineral oils. The Germ Process is the subject of patents in America, in the United Kingdom and in Europe.

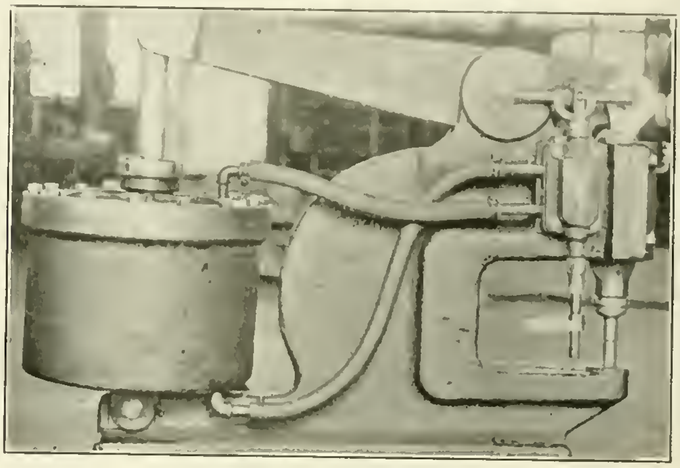
Portable Pneumatic Punch and Riveter

THE illustration shows a new combination punch and riveter designed and built by the Baird Pneumatic Tool Company, Kansas City, Mo. It is adapted to the punching of light structural shapes in shops where the range of work is of small dimensions. By taking out the punch and die and inserting rivet dies of the proper size, the machine may be operated as a riveter and can be used effectively on the fabrication of light frame work. The air cylinder is so cushioned as to prevent injury to the mechanism when used as a punch.

The tool is operated by a fourway valve, by foot pedal and hand movement, depending on whether it is used as a stationary or portable unit.

The machine is made with both 1-in. and 2-in. die travel and has a punching capacity of 1/8-in. to 5/8-in. holes in cold 3/8-in. plate, and has a riveting capacity of 3/8-in. cold or 5/8-in. hot rivets.

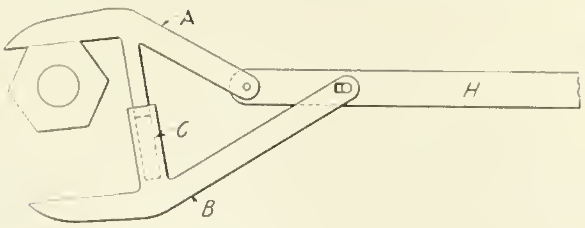
The tool delivers 35 tons pressure on the rivet punching dies and weighs 500 lb. complete. This punch and riveter can be used to good advantage on the quantity production of small shapes. It is portable, takes up but little floor space, and is stated to be economical in air consumption which is an important factor in machines of this character.



Baird Air Operated Punch and Riveter

Automatic Wrench of Simple, Compact Design

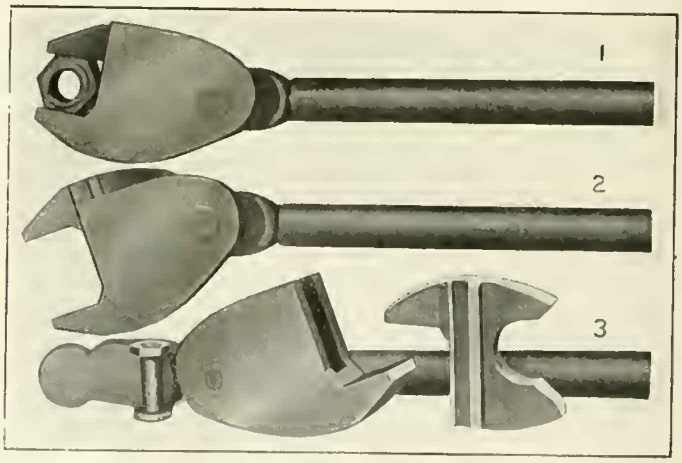
A SIMPLE, compact wrench, which is virtually automatic in action without the agency of a ratchet, has been developed recently. It was first used as a track wrench, but is equally applicable to smaller sizes of nuts. As illustrated, there are only four pieces to the wrench, the handle, interior jaw, exterior jaw and hinge pin. The interior jaw has a socket that fits over a knuckle on the end of the handle, while the exterior jaw encloses the interior jaw and is pivoted on a pin located a short distance behind the center of the socket about which the interior jaw revolves. The engaging faces of the two jaws have corresponding grooves so that the two jaws slide in a fixed relation to each other as they rotate about their respective centers on the handle.



Diagrammatic Sketch Showing Wrench Operation

The operation of the wrench is best understood by reference to the diagrammatic sketch. In this sketch the handle is represented by *H*, the interior jaw by *A*, the exterior jaw by *B*, while the engaging grooves of the two jaws are simulated by the plunger and cylinder arrangement at *C*. It is clear that when the handle is turned in a clockwise direction, the two jaws move away from each other and that when the handle is turned in the opposite or counter-clockwise direction, the two jaws move towards each other. The pin hole in the handle is slotted a sufficient amount to avoid any binding with the varying angular positions of the handle.

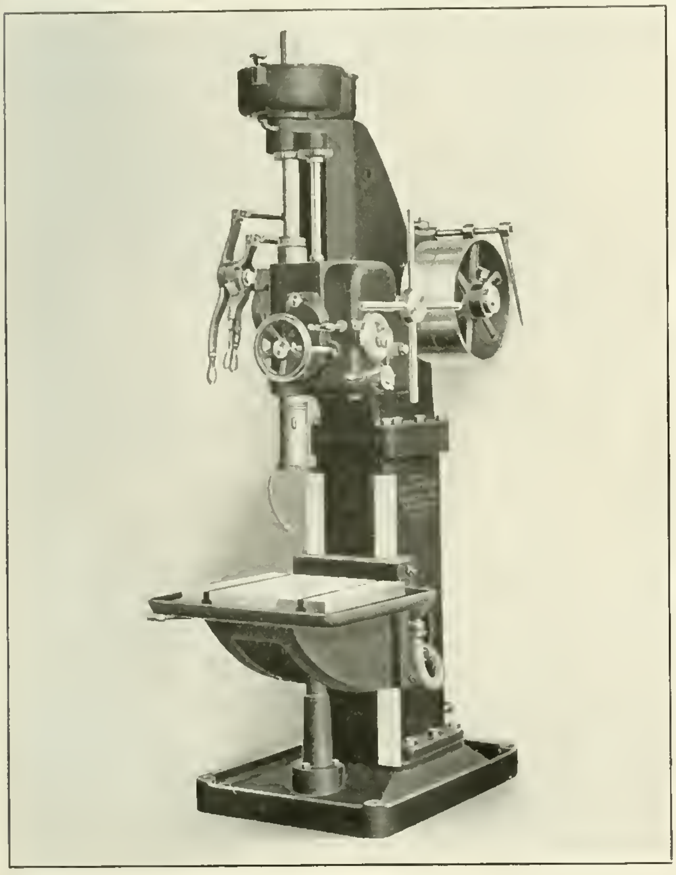
In using this wrench it is put on the nut in a position such that the direction in which the bolt is to be turned is the same as the direction in which the handle must be pulled in order to bring the jaws together. The wrench is held by the operator so that the nut is always in contact with the interior (upper) jaw. When the handle is turned back, the exterior jaw will clear the nut. The action is automatic, the jaws separate as the handle is pulled back to take a new grip and come together again the instant that the handle is pulled forward to turn the nut. The wrench is manufactured by the Allan-Diffenbaugh Wrench & Tool Company.



Allen-Diffenbaugh Automatic Wrench

High Capacity Single Purpose Drill

Designed to meet the demand for a single purpose drill of simple and rugged construction, a machine has been placed on the market recently by the Minster Machine Company, Minster, Ohio. It is well adapted for use on quantity production work. Referring to the illustration, the power is transmitted to a large driving pulley running at 600 r.p.m., and then through accurately ground, high carbon steel shafting to the hardened, stub tooth transmission gears. The gears are all accurately ground.



No. 12 Minster Junior Drill

This machine is equipped with three mechanical speed changes which are obtained through a sliding gear in the gear box, the teeth of which are rounded so as to enable the operator to change gears readily. The drive then passes through the hardened mitre gears to the vertical driving shaft, at the upper end of which are located the speed change gears. These gears in turn mesh with the gears on the flanged spindle sleeve. The drill comes regularly equipped with two sets of speed change gears, giving six speed changes, but any desired speed can be obtained by changing the combination of gears both on the vertical drive shaft and spindle sleeve.

A vertical shaft at the front of the machine drives the feedbox mechanism. The feedbox shafts are all accurately ground and cut steel gears are used throughout. Two mechanical feed changes are provided in the feedbox, which are compounded by transposing gears located conveniently on the front of the machine. The machine comes regularly equipped with one set of transposing gears, giving four feed changes. Any desired feed may be obtained by changing the feed transposing gears. The feedbox mechanism transmits its motion to the worm shaft, which in turn engages the large worm wheel keyed to the pilot shaft. Upon this shaft, a wide faced, stub tooth pinion is cut which engages the feed rack on the spindle sleeve. An efficient automatic feed disengaging device is provided.

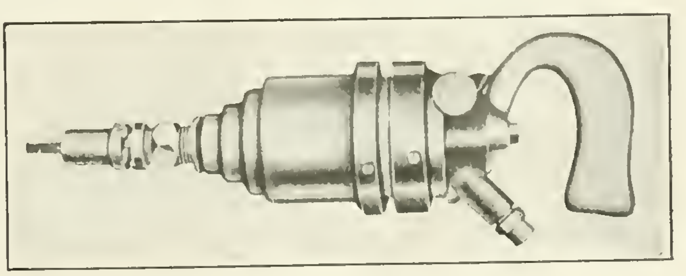
The spindle, which is made of high carbon forged steel, is driven by a sleeve upon which are mounted the driving gears. Two driving keys are mounted diametrically opposite in the spindle sleeve, which engage two keyways in the spindle. This method of driving divides the strain on the spindle and thereby eliminates any trouble which may be occasioned through the spindle binding. The two driving keys are held in position by screws.

The No. 12 Minster Junior drilling machine can be provided with a compound table in place of a plain table if desired, the compound table being of heavy construction and thoroughly gibbed to provide for extra heavy service. The bases of all machines are provided with slots for receiving adjustable motor bases. The motor is mounted directly upon this base and may be attached after the machine has been installed; since it will be necessary to drill but four holes in the base to mount the motor, the adjustable slides which are usually furnished with motors can be omitted. A 10-h.p. constant speed motor running at 1,100 to 1,300 r.p.m. is recommended.

Screw Driver Attachment for Air Motors

For use in pattern, cabinet, or any wood working shops where many screws have to be driven, the screw driver attachment illustrated has been developed as a time and labor saver by the Independent Pneumatic Tool Company, Chicago. It can be fitted to the spindle of an air motor or readily adapted to use with electric drills if desired.

It is stated that an experienced operator using one of these screw driver attachments can drive fifty screws per minute, with less effort and make a better finished job than by hand. The principle of operation is simple. Under normal conditions, the socket holding the screw driver is disengaged from the motor spindle so that the screw driver may be placed in the head of the screw while the motor is revolving. Pressure on the motor causes a shoulder on the part connected to the motor spindle to engage a recess in the socket and the screw driver revolves with the motor spindle. Removal of the pressure causes the parts to disengage. The arrangement illustrated measures 15 in. over all and will drive No. 12 wood screws 1¾ in. long.



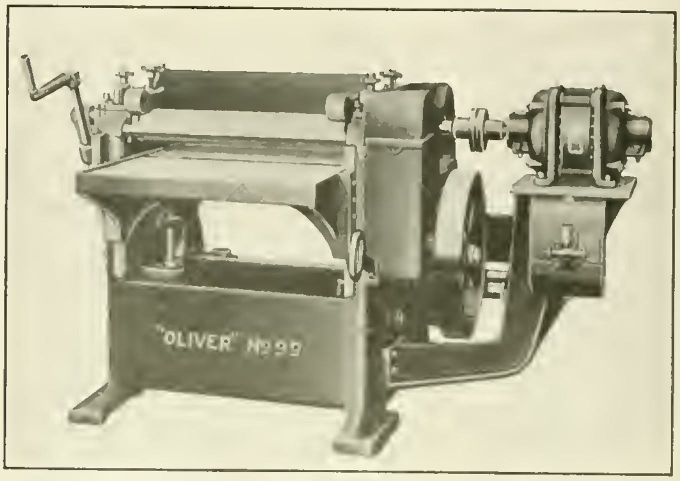
Thor Screw Driver Attachment

Direct Motor Drive for Surface Planer

The application of the individual motor drive to railway shop machinery has been extended to woodworking machines, a recent example of which is the motor-driven surfacer or surface planer developed by the Oliver Machinery Company, Grand Rapids, Mich. This machine is driven without belts or driving pulleys by means of a motor coupled directly to the cutting cylinder and providing a speed of 3,600 r.p.m. In order to provide the proper number of cuts per minute three high speed knives are furnished in the cutting head.

The particular advantages of this form of drive are a considerable saving in floor space, increased efficiency due to the lack of belts, greater safety in machine operation and the fact that the machine can be placed anywhere in a shop, regardless of the position of line shafts.

The Oliver single-cylinder surfacer is made of cast iron sides and ribbed girts, carefully machined and bolted together. Ample material in the flanges reduces vibration to a minimum and provides substantial floor support. An improved type of forged crucible steel cylinder, carrying two knives and steel chip breakers is provided. Two pressure bars, one acting before and the other after the cylinder, hold the work to the table. The front bar or chip breaker yields to any quality of cut. Positive feed is provided by means of 3½-in. forged steel feed rolls. The machine is designed to plane six inches thick and 20 in. wide, with a

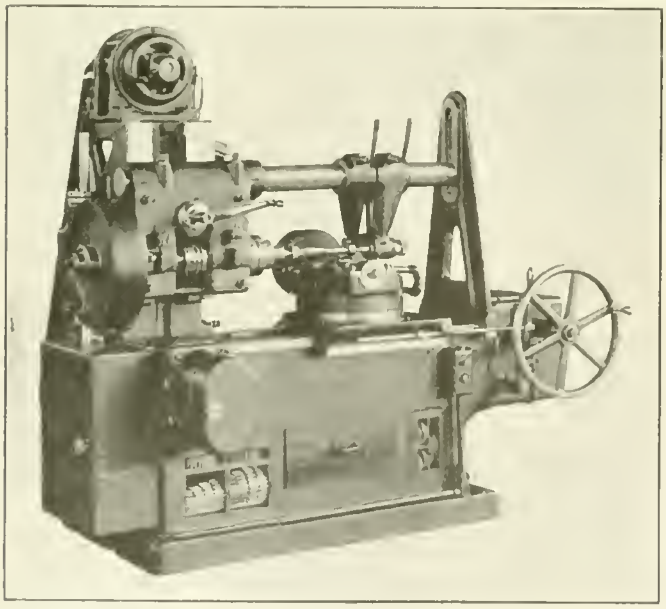


Surface Planer Arranged for Direct Motor Drive

lineal rate of feed of 24 ft. per minute. A five-horsepower motor is recommended to drive the planer.

Spur and Spiral Gear Hobbing Machine

For cutting spur and spiral gears also splining shafts and cutting ratchets and sprockets, the machine illustrated has been placed on the market recently by the Cincinnati Gear Cutting Machine Company, Cincinnati, Ohio. The gear hobber is particularly adaptable to the quantity production of spur and spiral gears but can be



Cincinnati 16-In. Gear Hobbing Machine

readily set up for machining a single spur gear. In cutting spiral gears, however, its advantage is only manifest in quantity production, the requirements of the set-up being such as not to lend themselves quickly to cutting occasional gears. The hobber is supplied with standard parts and change gears but for the manufacture of spiral gears it is necessary to provide special change gears.

Strength and rigidity are secured by the generous dimensions of the bed and housing of the hobber. The metal is distributed to provide the greatest stiffness possible and this contributes to the accuracy of the machine. The work spindle is horizontal and is supported rigidly by two long bearings in the work saddle. Both bearings are bronze bushed and the front bearing is tapered for taking up wear. The work saddle is taper gibbed to long narrow guides in a manner to prevent any sagging when the clamping bolts are loosened. Elevating and lowering are accomplished by means of a crank handle, the movement being recorded by a graduated dial reading to .001 in. The load is supported on ball bearing thrust collars making the action smooth and even. The indexing mechanism consists of a double thread worm and a cast iron worm gear which are entirely enclosed and run in a bath of oil, suitable adjustment being provided to take up wear. The indexing is continuous and automatic.

The guide of the hob slide is exceptionally long with square ways taper gibbed to reduce binding action. The design and construction are such as to provide for the proper swiveling of the hob spindle. This can be adjusted to approximately fifty degrees either side of zero and is set by a vernier reading to five minutes. An automatic stop for the entire machine at any point is provided for use on either belt driven or motor driven equipment. There is also a trip to stop the feed mechanism only.

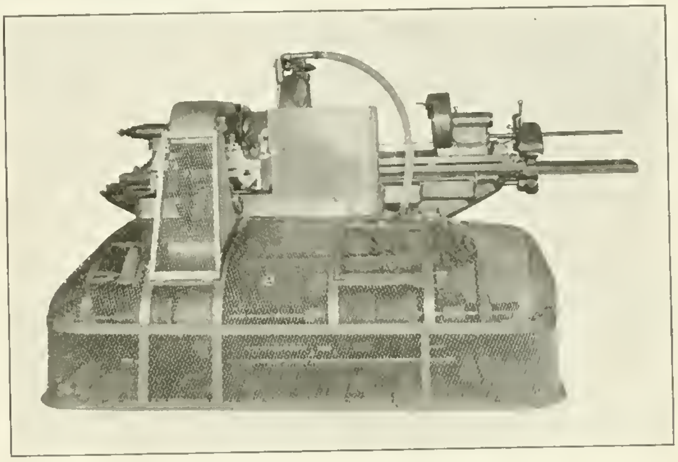
Changes in speeds and feeds are secured by means of removable change gears, a sufficient range being provided to meet all average conditions. Maximum production is insured by a cutting lubricant system and pump of ample capacity. Spur gears up to 17¼ in. in diameter with a 12 in. face and spiral steel gears with a diametral pitch of 3 can be cut. The maximum distance from the hob center to the spindle nose is 19½ in. The maximum diameter of the hob is 4½ in. Twenty-six changes of hob feed can be obtained and eight changes of speed. When a belted drive is provided as shown, the driving pulley is 15 in. in diameter with a 3¼ in. face to run at a speed of 400 r.p.m.

Plain Grinder With New Phantom Guards

PRACTICALLY all grinding machines made by the Modern Tool Company, Erie, Pa., are now equipped with new phantom guards as illustrated. The new guard, supplied with the machine and without extra cost, is a combination of expanded or perforated metal riveted to an angle iron frame, thus assuring both lightness and strength. Objections heretofore found with the old type of heavy, unwieldy, cast iron guard have been eliminated and the new type is light and easily handled. It affords pratically complete visibility of all moving parts which the old type of guard concealed. All gears, pulleys, and belts are completely enclosed.

The Modern phantom guard is a space-saver and permits machines to be set closer together. It is built to follow the lines of the machine. The corners, being rounded instead of square, do not project into the passageway. Hinged portions and hand holes make lubrication and minor adjustments easy without the necessity of removing the guard. The heavy cast iron type guard is cumbersome, and hard to handle, experience proving that lubrication and adjustments were often neglected because of difficulty in this respect.

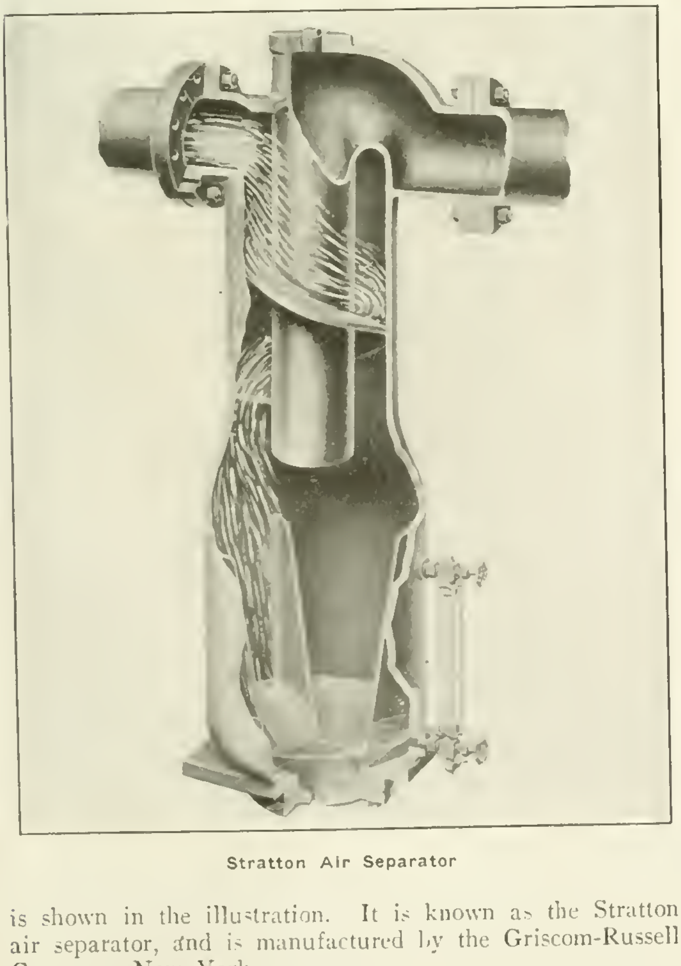
The feature of visibility will not only permit all moving parts to be seen, and watched, but will act as a check against accumulation of dirt. The new guard is supplied as a unit and can be placed in position or removed without the use of a wrench or screw driver.



Modern Grinder With Phantom Guard

Separating Water From Compressed Air

ALL railway shop men are familiar with the trouble due to condensed water getting into pneumatic tools and air operated devices throughout the shop. A simple device for removing this water from the air mains is shown in the illustration. It is known as the Stratton air separator, and is manufactured by the Griscom-Russell Company, New York.



Stratton Air Separator

The separator consists of a close grain, iron casting, designed to withstand a pressure of 160 lb. per sq. in. As air and the water come from the condenser they are compelled to follow a helical path which causes a swirling motion. The water, being heavier, is thrown by centrifugal force out of the path of the air and against the walls of the separator which it meets at an angle. There is no spatter or splash and the water follows the walls until its motion is checked in the receiving space at the bottom, from which it may be drained. The operation of the separator is purely mechanical and it is essential, for satisfactory results, that air entering the separator shall be at a sufficiently low temperature to insure all the water vapor being condensed. In order that the separation shall take place when the air is at its lowest temperature, it is desirable to install the separator as near as possible to the point at which the air is to be used. In other words, it is better to install a number of small separators on branch lines than to install one large separator on the main line from the compressor. In case of long air pipe lines out of doors where there is a possibility of freezing, the separator should be placed in the line at a point just before the pipe leaves the building.

The water level in the separator is indicated by a glass gage as shown and for convenience in operation it is recommended that a trap be installed to automatically drain the separator of water. Separators having various arrangements of inlet and outlet can be supplied to meet different piping arrangements and with air inlets up to 8 in. in diameter.

At a recent congress of the French Federation of Railwaymen, the former secretary, M. Bidegaray, was re-elected by 34 votes against 19 cast for Lardeaux, the extremist, who took an active part in promoting the recent abortive strike, according to a note in the Railway Gazette, London. M. Bidegaray was considered too moderate for the revolutionaries, who at the last congress ousted him from his position and then declared a strike. Three of the extremists are now under arrest and a warrant has been issued for the arrest of the fourth, who has so far eluded the police.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 10,500 copies were printed; that of these 10,500, 9,216 were mailed to regular paid subscribers, 14 were provided for counter and news company sales, 259 were mailed to advertisers, 32 were mailed to employees and correspondents, and 979 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 105,150, an average of 11,683 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulations (A. B. C.).

C. D. Young, general supervisor of stores of the Pennsylvania, has been appointed representative of the American Society for Testing Materials on Engineering Council, succeeding Albert Ladd Colby.

The Locomotive Superheater Company has received orders for 92 superheater equipments to be applied to seventy-five 4-6-0 locomotives and seventeen 2-10-0 locomotives to be built by 12 different locomotive builders in Belgium.

The Interstate Commerce Commission has ordered Class I railroads to file with it quarterly reports giving particulars of the number of employees of various classes in the service at specified times, of the service rendered by such classes of employees and of the compensation paid for that service.

A Materials Handling Section of the American Society of Mechanical Engineers was organized at a meeting in the Engineering Societies building, New York, August 13. Robert M. Gates, Lakewood Engineering Company, acted as temporary chairman. A nominating committee was appointed and ballots will be sent out for the election of officers just as soon as the committee makes its report.

The Russian Soviet government has sent Messrs. Krassin and Ivitsky to London to negotiate for the purchase of locomotives. Mr. Krassin is a representative of the Soviet government and Mr. Ivitsky is the engineer in charge of design. It is reported that Russia needs 5,000 locomotives, but these gentlemen will negotiate for the purchase of from 200 to 300. However, the Polish crisis has temporarily held up the negotiations.

The Joint Conference Committee of the national societies of civil, electrical, mechanical and mining engineers has issued an invitation to engineering and allied technical organizations to become charter members of the Federated American Engineering Societies, the organization conference of which was held in Washington, D. C., on June 3 and 4. The engineering societies are also asked to appoint delegates to the first meeting of the American Engineering Council, which will be held this fall.

The claim made by the railway car builders and repairers of Great Britain for an increase of 6 pence (12 cents) per hour on time rates with an equivalent increase on piece rates and of 3 pence (6 cents) per hour for apprentices has been refused by the Industrial Court. The employers contended that the increases already granted were sufficient to meet the increased cost of living and added that the high charges in connection with the car building trade were already causing a serious fall in the demand.

A despatch from Dallas, Tex., published in the Manufacturers Record states that $18,000,000 will be spent by the Santa Fe system for new equipment, to be delivered at the earliest possible moment. Orders have been placed with manufacturers for 50 locomotives of the most modern type for both passenger and freight service, 3,000 gondola cars, 2,500 refrigerator cars and 5,000 box cars. Fifteen hundred of the box cars will be built especially for the handling of automobiles and furniture. The $18,000,000 also provides for the purchase of a large number of passenger, mail, baggage and express cars.

A sectional committee of the American Engineering Standards Committee, 29 West Thirty-ninth street, New York, held an organization meeting on June 11, to undertake the standardization of plain cylindrical gages for general engineering work, under the sponsorship of the American Society of Mechanical Engineers. The immediate occasion for undertaking the work was a request of the British Engineering Standards Association for co-operation on the subject. It is understood that this committee will recommend to the American Engineering Standards Committee that the scope of the work should be broadened so as to cover all plain limit gages for general engineering work.

Chicago and Pittsburgh Sections, American Welding Society

A Chicago section of the American Welding Society was organized at a meeting of the members of the welding trade in Chicago on August 3. Representatives were in attendance from many of the railroads and also from many of the larger local industries. M. B. Osburn, assistant superintendent of the Pullman Car Works, was elected chairman; O. T. Nelson, president of the General Boilers Company, was elected vice-chairman, and L. B. Mackenzie, president of the Welding Engineer, secretary and treasurer.

The organization of the Pittsburgh Section of the American Welding Society was completed at a meeting held in the Chamber of Commerce auditorium at Pittsburgh, Pa., on August 12. Officers of the section elected at the meeting

are: Chairman, J. D. Conway, secretary and treasurer Railway Supply Manufacturers' Association; first vice-chairman, Dr. R. H. Brownlee, Brownlee Consulting Laboratories; second vice-chairman, H. H. Maxfield, general superintendent motive power, central region Pennsylvania System; temporary secretary, F. W. Tupper, American Welding Society; treasurer, F. O. Gardner, Pittsburgh Testing Laboratory.

MEETINGS AND CONVENTIONS

American Steel Treaters' Society.—The American Steel Treaters' Society and the Steel Treating Research Society will hold a joint convention at the Commercial Museum, Philadelphia, Pa., on September 14 to 18, inclusive. A comprehensive program will be presented covering all phases of the heat treatment of steel, including pyrometry, electric, gas and oil fired furnaces, forging temperatures, quenching mediums, carbonizing and the treatment of various special alloy steels. Several papers of especial interest to railroad men will be presented, the subjects including the heat treatment of locomotive forgings. Over 80,000 sq. ft. of floor space in the Commercial Museum will be devoted to an exhibit of heat treating appliances and heat treated products. More than 125 companies will be represented.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Section III.—Equipment Painting Division.—V. R. Hawthorne, Chicago. Convention, September 14-16, New American House, Boston.

American Railroad Association, Section VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. B. Baker, Terminal Railroad, St. Louis, Mo.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention September 1-3, Hotel Sherman, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—W. H. Eiseman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting, September 14, Paper on Car Records and Their Relation to Transportation and Accounting will be presented by J. A. Altimas, Canadian Pacific.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Next meeting September 8, at Hotel Morrison, Chicago. Paper on Reclamation of Car Materials will be read by J. L. McCann, B. & O.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York Next meeting September 10, Hotel Statler, Buffado, N. Y. Paper on Upkeep of Freight Car Equipment will be read by J. W. Senger, N. Y. C.

Chief Interchange Car Inspectors' and Car Foremen's Association.—J. C. Keene, Decatur, Ill. Convention, September 14-16, Windsor Hotel, Montreal, Que.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio Meetings second Tuesday in February, May, September and November.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention Sept. 7-10, 1920, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting October 12.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Next meeting, September 17. Discussion of the Association of Railway Executives' plans for increasing the efficiency of operation of the railways

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting, September 3. Problems of the short line railroads will be discussed by various speakers.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y. Convention September 14, Chicago.

Western Railway Club.—Bruce V. Crandall, Chicago. Next meeting September 20. The building of a locomotive in the plant of the

PERSONAL MENTION

GENERAL

C. H. Bilty has been appointed mechanical engineer on the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., having returned from service with the United States Railroad Administration.

W. J. Bohan, assistant mechanical superintendent of the Northern Pacific, with headquarters at St. Paul, Minn., has been appointed assistant general mechanical superintendent with the same headquarters.

J. B. Brown, master mechanic of the East Carolina division of the Seaboard Air Line, with headquarters at Andrews, S. C., has been transferred to succeed F. W. Knott as master mechanic of the Alabama division, with headquarters at Savannah, Ga.

R. M. Crosby, general master mechanic of the Northern Pacific with headquarters at Tacoma, Wash., has been promoted to mechanical superintendent of the lines west of Paradise, Mont., with the same headquarters.

H. M. Curry, mechanical superintendent of the Northern Pacific, with headquarters at St. Paul, Minn., has been appointed general mechanical superintendent with the same headquarters.

H. K. Fox, acting mechanical engineer of the Chicago, Milwaukee & St. Paul, has been appointed engineer of tests with headquarters at the Milwaukee shops, Milwaukee, Wis.

E. R. Gorman, assistant superintendent of the Eastern division of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at Eau Claire, Wis., has been appointed acting superintendent of motive power and machinery, with headquarters at St. Paul, Minn. Mr. Gorman succeeds J. O. Enochson, who has been relieved on account of ill health.

W. T. Hawkins has been appointed fuel agent of the Missouri Pacific, succeeding W. J. Roehl, who has been transferred.

George F. Hess, superintendent of machinery of the Kansas City Southern, has been appointed superintendent motive power of the Wabash, with headquarters at St. Louis, Mo., succeeding E. F. Needham, relieved of those duties at his own request because of ill health. Mr. Hess was born in Fort Wayne, Ind., and entered railway service as a messenger boy in the mechanical department of the Pennsylvania in 1886. After a short service as machinist apprentice in the Pennsylvania shops at Ft. Wayne he entered the employ of the Cleveland & Pittsburgh at Wellsville, Ohio, as a machinist. He was later employed by the Cleveland, Canton & Southern at Canton, Ohio; by the Atchison, Topeka & Santa Fe at Raton, N. M., and by the Wabash at Ashley, Ind. In 1897 he was promoted to roundhouse foreman at Montpelier, Ohio, and shortly after was transferred to Delray, Mich. He entered the service of the Grand Trunk as general foreman at Detroit, Mich., in 1899, and was later transferred to Battle Creek, Mich. In March, 1901, he was appointed enginehouse foreman on the Chicago, Rock Island & Pacific at Pratt, Kan. He was later transferred to Caldwell, Kan., where he remained until promoted to general foreman at the Forty-seventh street (Chicago) shops. He entered the service of the Baltimore & Ohio in March, 1903, as a master mechanic, with headquarters at Lorain, Ohio, and served in the mechanical department of this road during the next eight years. In August, 1911, he was appointed

superintendent of machinery on the Kansas City Southern, with headquarters at Pittsburgh, Kan., which position he occupied at the time of his recent appointment.

E. W. Hopp, master mechanic of the Racine and Southwestern division of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has been transferred to Aberdeen, S. D., as master mechanic of the Aberdeen division, succeeding G. Lamberg.

W. J. Hughes has been appointed master mechanic of the Racine and Southwestern division of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding E. W. Hopp.

C. G. Juneau, recently appointed acting master car builder of the Chicago, Milwaukee & St. Paul, has now been appointed master car builder, with office at Milwaukee, Wis.

G. Lamberg, division master mechanic of the Aberdeen division of the Chicago, Milwaukee & St. Paul, with headquarters at Aberdeen, S. D., has been promoted to superintendent of shops, with headquarters at Minneapolis, Minn.

Lewis K. Sillcox, whose appointment as general superintendent motive power of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, was announced in the August issue, was born in Germantown, Pa., on April 30, 1886, and was educated at Trinity School, New York, and the Mechanical and Electrical Institute of Brussels. He entered railway service in 1903 as an apprentice in the High Bridge shops of the New York Central, leaving there in 1906 to go with the McSherry Manufacturing Company at Middletown, Ohio. He resigned from that company as assistant shop superintendent in 1909 to become shop engineer of the Canadian Car & Foundry Company at Montreal. He left his position with the latter company in 1912 to become mechanical engineer of the Canadian Northern. In 1916 he was appointed to a similar position with the Illinois Central in charge of car work, from which he resigned on February 1, 1918, to accept an appointment as master car builder of the Chicago, Milwaukee & St. Paul.

On June 1, of this year the appointment of Mr. Sillcox as assistant general superintendent motive power of the Chicago, Milwaukee & St. Paul became effective.

Silas Zwight, assistant mechanical superintendent of the Northern Pacific, with headquarters at St. Paul, Minn., has been promoted to mechanical superintendent of the lines east of Paradise, Mont., with the same headquarters.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

G. F. Egbers, master mechanic on the Northern Pacific with headquarters at Pasco, Wash., has been appointed master mechanic of the Idaho division, with headquarters at Parkwater, Wash.

H. McLendon, general locomotive foreman of the Seaboard Air Line at Savannah, Ga., has been promoted to master mechanic of the East Carolina division, with headquarters at Andrews, S. C., succeeding J. B. Brown.

James Simpson, master mechanic on the Northern Pacific, with headquarters at Spokane, Wash., has been promoted to general master mechanic of the lines west of Paradise, Mont., with headquarters at Tacoma, Wash.

J. E. Stone has been appointed assistant master mechanic of the Southern Pacific, with headquarters at Sparks, Nev., succeeding Paul Jones, who has resigned.

C. A. Wirth, road foreman of engines on the Northern Pacific, with headquarters at Pasco, Wash., has been appointed master mechanic, with the same headquarters, succeeding G. F. Egbers.

Charles F. Parsons, whose appointment as general master mechanic, of District No. 1, of the New York Central at Albany, N. Y., was announced in last month's issue, was born February 14, 1870, at Ilion, N. Y., and received his education in the grammar schools. In June, 1889, he entered the employ of the West Shore at Frankfort, N. Y., as messenger boy and was transferred to the store department in the fall of 1890. In the fall of 1892 he entered the locomotive department as a machinist apprentice. On the completion of his apprenticeship he resigned to accept a position as machinist with the New York, Ontario & Western, remaining with that company until November, 1896, when he returned to the West Shore as a locomotive fireman. In November, 1902, he was promoted to engineman and in April, 1910, to road foreman of engines on the Mohawk division. He became master mechanic of the Mohawk division on July 1, 1918.

Charles F. Parsons

John F. Long, district maintenance of equipment inspector of the Baltimore & Ohio, has been appointed master mechanic of the Connellsville division, Eastern district, with headquarters at Connellsville, Pa., succeeding H. J. Burkley, assigned to other duties. Captain Long served in France during the recent war in the capacity of inspector of equipment at Santes, France, master mechanic of the Paris & Mediterranean Railroad at Nimes Garde, France, and master mechanic at San Sulpice, and was commander of the 395th Casual Company, 35th Engineers. Previously he was employed on the St. Louis-San Francisco as machinist, assistant foreman, division foreman, general foreman, master mechanic and shop superintendent, and was for eight months with the United States Railroad Administration as assistant supervisor of equipment.

J. F. Long

SHOP AND ENGINEHOUSE

C. M. Jacobson, shop superintendent of the Seaboard Air Line, with headquarters at Jacksonville, Fla., has been transferred to Portsmouth, PVa., succeeding B. E. Greenwood, assigned to other duties.

F. W. Knott, master mechanic of the Alabama division of the Seaboard Air Line, with headquarters at Savannah, Ga., has been appointed shop superintendent at Jacksonville, Fla., to succeed C. M. Jacobson.

SUPPLY TRADE NOTES

Willaim S. Noble has been appointed manager of the railroad department of the Standard Paint Company, with offices in the Woolworth building, New York, and Plymouth building, Chicago.

George B. Malone, general manager of the K-G Welding & Cutting Company, New York, has also assumed the duties of district manager of the Philadelphia territory and has his office at 929 Chestnut street, Philadelphia, Pa.

Julius Janes, formerly president of the Standard Steel Castings Company, Cleveland, Ohio, has recently become associated with the Farrell-Cheek Steel Foundry Company, Sandusky, Ohio, as sales representative in Cleveland and Cuyahoga county.

The Mono Corporation of America announces the removal of its main office from Buffalo, N. Y., to 25 West Broadway, New York city, where a complete line of the automatic gas analyzing instruments manufactured by this corporation will be displayed.

A. B. Way, until recently secretary and general manager of the Bridgeport Chain Company, has become affiliated with the Chain Products Company, Cleveland, Ohio, in the capacity of district sales manager for New England, with headquarters at New York.

The Rogatchoff Company, 205 Water street, Baltimore, Md., has recently been incorporated under the laws of Maryland, with a capital of $50,000, to manufacture adjustable crossheads for locomotives. A E. Davis is president, Theodore Rogatchoff is vice-president and H V. Baker, secretary and treasurer.

William N. Thornburgh, Inc., and the Drexel Sash & Door Company, Chicago, have been consolidated and are now known as the W. N. Thornburgh Manufacturing Company, manufacturers of Thornburgh dust guards. The new plant and offices are located at Fiftieth avenue and Thirty-second street, Cicero, Ill.

New offices have been opened by the American Rolling Mill Company, Middletown, Ohio, in the Hibernia Bank building, New Orleans, La., to cover the southern states, including Texas, excepting El Paso. The office will be in charge of C. C. Lynd, who has represented the American Rolling Mill Company at Atlanta, Ga., for several years past.

The Oxweld Acetylene Company, New York, has established Pacific Coast sales and distributing headquarters at San Francisco, with offices at 1077 Mission street. Additional sales representatives' offices are maintained at the following points: Los Angeles, Salt Lake City, Portland, Seattle. Leo Romney is Pacific sales manager, with headquarters at San Francisco.

The Mesta Machine Company, Pittsburgh, Pa., has opened an office in the Singer building, New York, from which point all its foreign business will be handled. The New York office will also be the sales office for the New York and Eastern states territory. M. M. Moore, the export sales manager, who has just returned from a several months' European trip, will be in charge.

Arthur Jackson, formerly of the Gould, Shapley & Muir Company, Brantford, Ont., has been appointed Potter & Johnston representative with the Yamatake Company of Tokio, Japanese agents for the Potter & Johnston Machine Company, Pawtucket, R. I. Mr. Jackson was at one time employed by the Jones & Lamson Company, Springfield, Vt., but for the past five years has been demonstrating and selling Gridley automatics in Great Britain.

A large interest in the Youngstown Steel Car Company, Youngstown, Ohio, has been acquired by the Youngstown Sheet & Tube Company, and the Brier Hill Steel Company, both of Youngstown. The plant represents an investment of about $1,000,000 and will be used chiefly for repair work. It is intended later to erect additional works for the building of steel cars complete and plans have been outlined for a plant to cost at least $5,000,000.

The Uehling Instrument Company, 71 Broadway, New York, manufacturer of fuel economy equipment, announces that it is now being represented in the New England states by the Smith Engineering & Supply Company, 89 State street, Boston, Mass., manufacturers' agents and engineers, specializing in power plant equipment. S. W. Smith, president of the latter company, was until very recently associated with the Uehling Instrument Company, with headquarters in its New York office.

M. E. Hamilton has become associated with the Automatic Straight Air Brake Company as field engineer. The company has started to build up its field organization to take care of the brake installations which it will soon be making. Mr. Hamilton entered railroad service on the C. K. & N. Railway (construction company of the Chicago, Rock Island & Pacific) in the fall of 1887 as fireman. Early in 1890 he entered the service of the Atchison, Topeka & Santa Fe as a brakeman, and in 1891 was promoted to conductor at Galveston, Tex. From the fall of 1901 he worked for the Galveston, Houston & Henderson as engineer and roundhouse fore-man until 1903, when he went back to the Santa Fe as engineer. In 1906 he was made air brake insructor; in 1909 he was made general air brake insructor of the system with headquarters at Topeka, where he remained until 1911, when he became railroad representative for the Garlock Packing Company. He re-entered railroad service as general air brake inspector for the St. Louis-San Francisco in 1915 and in 1919 resigned to enter government service as field inspector for the Bureau of Safety, Inetrstate Commerce Commission.

M. E. Hamilton

The Heald Machine Company, Worcester, Mass., announces two recent changes in organization. W. A. Erickson, who has been demonstrating and selling in the New York district, has been made district sales manager in Buffalo and will open a branch office at a location as yet undecided upon. S. M. Hershey has resigned as sales manager at Philadelphia and his position will now be held by A. Sleath, who has been representing the Heald Machine Company in the south.

The Bourne-Fuller Company, Cleveland, Ohio, and the Upson Nut Company, Cleveland, Ohio, have effected a consolidation under the name of the Bourne-Fuller Company,

Cleveland, Ohio. The ownership and management of these companies has been identical for the past eight years. The Upson Nut Company plants will continue operation as the Upson Works of the Bourne-Fuller Company, the product of its nut and bolt departments being marketed under the same trade-marks as in the past.

George E. Long, senior vice-president of the Joseph Dixon Crucible Company, Jersey City, N. J., following his re-election as a member of the board of directors at the annual meeting, announced his decision to retire from the office of vice-president after 43 years of active service with this company, having begun as stenographer and advanced to the offices of secretary, treasurer and vice-president, respectively. He has taken an active part in the introduction of graphite as a lubricant and of silica-graphite paint.

H. A. Noble, vice-president of the Pittsburgh Spring & Steel Company, Pittsburgh, Pa., has been elected president to succeed D. C. Noble, deceased. S. F. Krauth, secretary and assistant treasurer, has been elected vice-president and treasurer, with headquarters at Pittsburgh. J. N. Brownrigg, eastern sales agent at New York, has been elected vice-president and eastern representative at New York, and M. F. Ryan, western sales agent at Chicago, has been elected vice-president and western representative, with headquarters at Chicago.

The personnel of the railway department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been rearranged and promotions have been made as follows: W. R. Steinmetz, manager of the heavy traction section, with Franklin W. Carter in charge of both foreign and domestic negotiations; E. D. Lynch, manager of the light traction equipment section, with George Skipton in charge of negotiations; J. L. Crouse, manager of the new railway apparatus and supply section, and K. A. Simmon, manager of the safety car and foreign railway equipment section.

Robert M. Gates has been appointed managing engineer in charge of the Philadelphia, Pa., district of the Lakewood Engineering Company, Cleveland Ohio, with offices at 1034 Widener building, Philadelphia. Mr. Gates is a graduate of Purdue University. He has been active in organizing the Material Handling Section of the American Society of Mechanical Engineers, and is acting as chairman of that section during its period of organization. He has devoted the past 12 years to the design, application and engineering surveys of mechanical means of conserving labor in the construction, industrial and transportation fields.

The sales, purchasing, accounting and executive departments of the Reed-Prentice Company, Worcester, Mass., Becker Milling Machine Company, Hyde Park, Mass., and Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., were recently combined and the main offices are now permanently located at 53 Franklin street, Boston, Mass. The various agencies throughout the United States that formerly handled the products of these factories are now displaced by direct factory branches in the various machine tool centers of the United States, and the three companies now have combined sales branches in Boston, Worcester, New York, Detroit, Chicago, Cleveland, and Indianapolis. The locations of the various offices are as follows: Boston, 53 Franklin street, executive office; Worcester, Reed-Prentice Company, Cambridge street; Whitcomb-Blaisdell Machine Tool Company, 134 Gold street; Hyde Park, Boston, Becker Milling Machine Company; New York, fifth floor, Grand Central Palace; Chicago, 26-28 North Clinton street; Detroit, 408 Kerr building, corner Fort and Beaubien streets; Cleveland, 408 Frankfort avenue; Indianapolis, 940 Lemcke annex.

TRADE PUBLICATIONS

Hardening Room Equipment and Supplies.—The Waisner Manufacturing Company, Rockford, Ill., has issued a 12-page booklet describing its line of lead hardening furnaces, lead furnace preheating attachments, coke furnaces, carbonizing pots and carbonizing material.

Locomotives for Logging Service.—Record No. 96, published by the Baldwin Locomotive Works, Philadelphia, Pa., describes the conditions which must be met by locomotives in logging service and recommends types that are best suited for the purpose. Numerous locomotives built for this kind of service are illustrated and general data are given for each.

Vanadium Steel.—The Vanadium Alloys Steel Company, Pittsburgh, Pa., has issued a small booklet covering Vasco vanadium steel, a general utility tool steel for all purposes, particularly adapted to resist shock and strain. This steel is made in six different types, each containing a different percentage of carbon. The classes of work for which each is especially suited are listed and directions are given for the heat treatment of each type.

Gages.—A new gage catalogue has been issued by the Greenfield Tap & Die Corporation, Greenfield, Mass. In addition to being a catalogue it contains valuable screw cutting and gaging data, and describes the latest methods in precision measuring and inspection. Graphic tolerance charts to aid in establishing manufacturing limits, and complete gaging systems to assist manufacturers in promoting standardization of their products are also included in the catalogue.

Shop Machinery and Tools.—The Brown & Sharpe Manufacturing Company, Providence, R. I., has revised its catalogue of machinery and tools. The new catalogue, known as No. 137, contains 609 pages, 5¾ in. by 3½ in., and is illustrated. It covers the complete line of equipment manufactured by this company, including milling and grinding machines, automatic gear cutting and screw machines, cutters, machinists' and test tools, and contains a number of tables for the convenience of mechanics.

Superheaters.—Bulletin T-5, published by the Locomotive Superheater Company, New York, describes the advantages of superheated steam for stationary power plants and presents the engineering reasons for these advantages from a new angle. The argument is clear and concise and should be of interest to all power plant owners and operators in every industry or power plant service. Charts are included showing the effect of superheat on steam consumption, the superheat required to prevent condensation and the increase in thermal efficiency due to superheat.

Surplus War Material.—The Way to Increased Production is the title of a booklet issued by the du Pont Chemical Company, Wilmington, Del., giving some facts regarding the sale of surplus war material taken over from the war plants of the du Pont Company. Although the book is not complete as an inventory of the material on hand, it gives an idea of the great variety of supplies for sale, including a large range of articles in daily use, also flat and gondola cars, gasoline and electric storage battery locomotives, steam power equipment, hoists, etc. General machine shop tools of all kinds are on hand, and there is also special machinery built for manufacturing purposes peculiar to the powder business but which can in many instances be used in other industries with slight changes.

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THE CONVENTION NUMBER

SEPTEMBER is growing in popularity as the season for conventions of the mechanical associations. During one week last month, three railroad organizations met simultaneously in Chicago, Boston and Montreal, and at the same time the Society for Steel Treating, which numbers many railroad men among its members, was in session in Philadelphia. Under these circumstances it is difficult for the mechanical department officer to decide which meeting to attend and no doubt many were unable to be present at conventions in which they were vitally interested. The activities of the associations are of such importance to the readers of the *Railway Mechanical Engineer* that the editors felt it advisable to publish the full reports as promptly as possible. For that reason this issue is devoted principally to the proceedings of five of the associations that met last month and on the following pages will be found editorials commenting briefly on the outstanding features of the conventions. The account of the meeting of the Chief Interchange Car Inspectors' and Car Foremen's Association could not be included in this number because of delay in getting out the stenographic report. A movement is now under way to arrange for holding several conventions in the same location during successive weeks next year. This will not only be convenient for the supply concerns, but will also do away with having several conventions meeting at the same time.

Amalgamation of Mechanical Associations

The question of amalgamation with the American Railroad Association as divisions of Section III-Mechanical has been before practically all of the so-called minor mechanical department organizations. Definite action has already been taken by the Master Painters' Association, now the Equipment Painting Division of Section III-Mechanical, and by the American Railway Tool Foremen's Association. The Air Brake Association and the Master Blacksmiths' Association have acted favorably on the proposal, subject to ratification of the final negotiations at next year's conventions. No definite action has been taken by the other organizations. There is a natural reluctance on the part of the minor organizations to lose their identity and there are good grounds for justification of this attitude. It must be remembered that these associations were not organized by the railroads. They owe their existence to the enterprise of leaders among the men in the fields represented and such railroad support as they have secured has been earned by a demonstration of the value to the railroads of such organizations. Under these circumstances the desire to retain their identity and a high degree of freedom of action must not be condemned. On the other hand it must be admitted that the value of their work to the railroads could be greatly increased if the energy of the various associations were to be directed so that less overlapping and better co-ordination would result. The principal value of the associations to the members themselves is educational: and while they serve this purpose very well, it undoubtedly could be equally well served, were they to become parts of an organization which would make their work of much greater value to the railroads. It must be said that the committee investigations of the independent associations are seldom authoritative as now conducted and there are many big problems that should be analyzed which the associations are not in a position to handle with their present organizations. Under the plan of organization proposed by the American Railroad Association the individual associations retain "home rule" and a large measure of their identity. For such sacrifices of sentiment as they make they receive in return the assistance of the secretary of Section III-Mechanical, an opportunity to do more effective work and the prospect of good work receiving a recognition which it is not now accorded. The invitations extended by Section III-Mechanical present opportunities which the minor organizations can ill afford to pass by.

THE TRAVELING ENGINEERS' CONVENTION

The Traveling Engineers' Association may not be the most technical, but it is assuredly one of the most practical of the railway mechanical associations. Moreover, it has the reputation of being one of the hardest working bodies and the recent convention in Chicago was no exception to the rule.

* * *

Fuel Economy in the Lime Light

First and foremost in recent meetings of this association comes the fuel problem, the question of obtaining the maximum use out of every pound of coal. At this convention the operation and maintenance of mechanical stokers was considered from the viewpoint of *efficiency* and *economy*. Stoker manufacturers know that the locomotive stoker must live down the reputation of being an excessive fuel consumer. Spark losses with stoker operation are high and every effort must be made to eliminate this and other waste incident to the use of mechanical stokers. The secret of efficient stoker operation lies in the education of firemen. The stoker is automatic only in a limited sense; it will not perform efficiently unless handled intelligently.

* * *

The Thermic Syphon

Locomotive boilers have never been designed with a view to promoting circulation, although this is always the first consideration in the design of efficient water tube boilers for power plant practice. Limitations with respect to size and capacity have governed locomotive boiler construction and water circulation has developed in just about the same manner that "Topsy" grew up. The principal claim for economy and increased boiler capacity with the application of the thermic syphon lies in the fact that it creates a defined path for circulation in addition to increasing the evaporating surface of the firebox. Some excellent results are being obtained with this device as outlined in one of the most interesting papers presented at the convention.

* * *

The Back Pressure Gage

Notwithstanding the fact that the effect of excessive back pressure on the operation of locomotives is well known, it has been given little attention in practical locomotive operation. The primary object of adjustments of draft appliances is, of course, to improve the steaming of the locomotive, and so long as steam enough can be generated to do the work little attention is paid to the effect of the adjustments on the steam economy of the engine proper. Back pressures as high as 20 lb. and 25 lb. are not infrequently attained in every day service and seldom are disclosed so long as the locomotive maintains schedules or handles its tonnage. It is true that there is a growing dissatisfaction with the status of our knowledge of the locomotive front end, but it has not yet reached the point where the railroads are willing to take the measures necessary to place front end design on a scientific instead of a rule-of-thumb basis. As a means of disclosing just how bad conditions are the use of the back pressure gage mentioned in the report of the committee on draft appliances of the Traveling Engineers' Association is worthy of general application. The device is nothing more than a pressure gage in the cab, connected by suitable branch pipes to the exhaust cavities of the cylinders. Ultimately the greatest return from the use of this device undoubtedly would be the sentiment its disclosures would create in favor of a scientific investigation of the whole problem of locomotive drafting. But it would also be of immediate value in comparing draft conditions on various locomotives of the same class; it would show why some locomotives are unable to maintain schedules well within the capacity of others of like design.

THE PROBLEMS OF THE GENERAL FOREMEN

Almost every craft and every department of the railroad shop has a separate association which considers and reports on its own specialized branch of the work; in fact, the field might seem to be covered so thoroughly that there is little left for the General Foremen's Association to discuss. Undoubtedly the activities of this association should be devoted, not to the details of shop practice, but rather to the broad question of management. At the last convention more than ever before this underlying idea was brought out.

* * *

Handling the Labor Problem

Probably no single question has caused so much concern to those who are responsible for shop output as the problem of handling men. There is no doubt that on the whole there has been a falling off in output per man during the past four years and even increased wages have had little effect in speeding up production. The reason is probably to be found in the feeling of unrest that has been almost universal during the last few years. Efforts to overcome the decrease in output have often been unsuccessful because the decreased production was a result of general conditions. Apparently the turning point has come and improvement should be apparent within a short time. The present wage scale is satisfactory to a great majority of the employees. Reductions in prices give promise of a decrease in the cost of living and with slack times in numerous industries, the employees will realize the benefit of the continuous employment which railroad service offers. Nevertheless the handling of men will continue to be a problem. The day of the boss, the driver, is gone. To get results under present conditions the foreman must be a leader, one who can appeal to the men through a study of the motives that spur them to action. Even with the unfavorable conditions existing during the past two years some shops have made remarkable records in maintaining their output. Under present conditions it should be easier to obtain the desired results.

* * *

The Operating Viewpoint

That the General Foremen's Association is looking beyond the internal problems of the shop is shown by the discussion of engine failures and running repair costs. The ultimate object in conducting a railroad is to produce transportation at the lowest cost per ton mile and per passenger mile. The mechanical department officer can best help to insure economical operaton if he keeps this constantly in mind. Too many records for low cost of classified repairs have been made by slipshod methods which have resulted in loss of service and heavy expenditures for running repairs. In view of the practical impossibility of keeping a record of running repair costs for individual engines as is done in back shop work, the cost of classified repairs should not be taken as the most important index of the efficiency of the mechanical department. Tests have shown that even slight defects in valve gears, valves and pistons will cause a considerable increase in the fuel consumption. Failure to make minor repairs promptly is often responsible for engine failures. The few dollars that may be saved in making classified repairs are lost many times over if the work is slighted and the expenditures for fuel and for wages of train crews are increased. Another angle of the maintenance problem that deserves attention is the matter of clean engines. It is natural for enginemen to take pride in such a wonderful piece of machinery as the modern locomotive, but if the whole engine is covered with filth it becomes repulsive and in that condition the engineman is almost certain not to give the machinery the minute and painstaking attention that is so essential for securing the best results.

THE PAINTERS' CONVENTION

Of the several conventions held during the month of September, the meeting of the Equipment Painting Division of Section III-Mechanical, at Boston, was in many respects the most interesting because it marked the fiftieth anniversary of the association that has been known for many years as the Master Car and Locomotive Painters' Association.

* * *

From the chemical standpoint the most important problems in regard to paint relate to the manufacture and use of substitute materials for the more expensive elements that for years have been regarded as essential to the manufacture of high grade protective and decorative coatings. Turpentine has become a very expensive ingredient in paint; and when it is realized that it is not a permanent element in the finished surface but rather a vehicle assisting in the mechanical application of the paint it seems logical that among the multitude of available petroleum products a distillate could be found which would serve the purpose. Opinion at the convention varied as to the efficacy of these substitutes, but it should be noted that the representative of at least one very important railroad declared in favor of a substitute for turpentine and stated that he was using this material on an extensive scale with entirely satisfactory results. The railroads are striving for economy in every direction and the painters should lead rather than follow in the procession. Those who object to the use of a substitute for turpentine should make sure of their ground before advising their railroads that a cheaper substitute cannot be successfully used.

Regarding Substitutes for Turpentine

* * *

Sentiment at the Painters' Convention was strongly in favor of using only the best materials. Any material which tends to lessen the durability of the painted surface is costly because it increases the labor that must be expended in the upkeep of the car and labor is a much more expensive item these days than paint. It would be extremely costly to use inferior materials that made it necessary to paint a car more frequently than if better materials had been applied or to use cheaper materials that allowed the steel surface to deteriorate when more expensive materials would have prevented the damage. These considerations in turn suggest the interesting question as to whether the quality of paint can be wholly determined by a chemical formula. There are many who contend that the preparation of paint is an art and that only the most skilled artisans are capable of mixing the ingredients in such proportion as to obtain a satisfactory paint. The technical staff of the Railroad Administration prepared specifications upon which all of the paint required for the standardized equipment was purchased. Some complaints were registered at the time, but the paint purchased was generally well regarded. It would be very interesting to know how this paint has stood the test of time.

Use Only the Best Materials

* * *

The most practical and progressive action taken by the painters at this convention was in regard to the uniform stencilling of freight cars. This was unanimously endorsed and the action of the association was also in favor of placing upon the owning road the cost of painting special badges or trade marks. It was shown that the cost of this special decorative work was considerable and that uniform stencilling would result in a considerable saving to all roads if universally adopted. It appears that many railroads have already adopted the uniform stencilling.

Uniform Stencilling Endorsed

THE TOOL FOREMEN'S CONVENTION

At the tenth annual convention of the American Railway Tool Foremen's Association, held at the Hotel Sherman, Chicago, September 1 to 3 inclusive, definite affirmative action was taken on the question of amalgamation with the American Railroad Association, Section III—Mechanical The tool foremen, therefore, became the second of the so-called minor mechanical department organizations to join the American Railroad Association. The convention was well attended and technical reports and papers of exceptional value were read, followed in many cases by animated discussions.

* * *

Several papers were presented on special tool room devices and it developed that there are few tool room foremen who do not have a number of special and effective devices for performing various operations in the shop. These devices should be made known to other foremen through the medium of the association and various technical journals. It was pointed out that the future of the tool room foreman lies not in his ability to turn out satisfactory small tools and machine tool cutters, but in the extent to which he studies the problems of the other departments of the shop with a view to developing special jigs and tools to reduce the time and labor required on machine and erecting floor operations.

Special Tool Room Devices

* * *

Members who took part in the discussion of the paper on "Issuing and Checking Tools in Locomotive and Car Shops" were practically unanimous in support of the system of issuing by check number. Checks given to the men on entering the service should be presented at the tool room for all tools except chisels and machine tools. Periodical inspections of cupboards will serve as a check on the operation of the system and at the same time bring to light many tools that are being hoarded by mechanics against possible use. This condition is especially evident when there is a shortage of any particular kind of tool. Irregularities and disobedience of shop rules regarding the handling of tools should not be allowed to pass unnoticed.

Method of Issuing Shop Tools

* * *

Especial interest was displayed in the report of the Committee on Standardization of Boiler and Staybolt Taps given in detail elsewhere in this issue. Seven standard taps were recommended, including a 36-in. staybolt tap, a special spindle tap for work behind frames, a 24-in. staybolt tap made in three lengths and a button-head radial staybolt tap. These first four taps are made with Whitworth threads, 12 per in., this thread being recommended because it has a greater tensile strength and maintains its original diameter longer than either the V-thread or the U. S. Standard. It was pointed out that staybolt cutting machines must be checked often to make sure they are cutting accurate staybolt threads of the correct diameter. Boiler head and washout plug taps were recommended with a ¾-in. taper in 12 in. and 12 U.S. standard threads per in., the latter provision being made because these taps are often manufactured in railway shops and the U.S. standard thread is less difficult to make than the Whitworth. The committee maintained that the adoption of standard taps as recommended would eliminate many irregularities and simplify the manufacture of taps for this particular service. It was also felt that under present conditions satisfactory taps can be secured at a more reasonable price from any first class manufacturer than can be made locally in a railroad shop.

Standardization of Boiler Taps Recommended

THE STEEL TREATERS' CONVENTION

THE truth of the old motto "In union there is strength" seems to be demonstrated once more by the amalgamation of the American Steel Treaters' Society and the Steel Treating Research Society to form one big organization of men interested in steel treating. The new organization, known as the American Society for Steel Treating, springs at once into prominence among the American technical societies; its remarkable growth and strength were convincingly shown at the second annual convention and exhibition held at Philadelphia, September 14 to 18. Many valuable papers, some of which are abstracted in this issue, were read and presented by title at the technical sessions. With an exhibition distributed over 80,000 sq. ft. of floor space, practically every phase of the heat treating industry was represented. The present membership of the society is estimated at 2,800, more than one-half of whom attended the convention.

* * *

Relative Efficiency of Fuels

Several papers were presented on the relative efficiency of fuels and special emphasis was laid on the high cost and growing scarcity of fuel oil. Discussion brought out the fact that the average fuel oil furnace without proper equipment for vaporizing the oil, mixing it with air, and a pyrometer to indicate temperatures, wastes at least 33 per cent of the heat of the oil. This statement was made by competent authorities and indicates the importance of proper fuel mixing and temperature control apparatus to increase the efficiency of furnace operation. Owing to the fuel oil situation, the possible necessity of changing over to gas or electric furnaces was pointed out, with resultant advantages in greater flexibility, better control of furnace atmosphere and more uniform temperature of heated area.

* * *

Conclusions Regarding Fatigue Strength

A question of particular interest to railroad men in view of the attempted use of heat treated steel for locomotive motion work was brought out in the discussion of heat treatment and fatigue strength of steel. The conclusions were that there is only one quenching and one drawing temperature for maximum fatigue strength. Decarbonization has a detrimental effect on fatigue strength and parts should be heated in a non-oxidizing atmosphere. Duplication of regular heat treatment will hasten failure of such parts as have already been subjected to repeated stresses. It was pointed out that these conclusions hold for carbon steel and not necessarily for all alloy steels.

* * *

Heat Treating High Speed Steel

The discovery of high speed steel by two American metallurgists, Taylor and White, revolutionized the steel treating industry and made possible production records never before thought of. The best results with any kind of tool steel, however, can be secured only by proper heat treatment. Several papers were presented on the heat treatment of high speed steel and showing the results of actual tests. The imperative need for better shop equipment for heat treating steel was pointed out. Altogether aside from the question of fuel economy, high speed steel is too expensive to be spoiled or heat treated in such a way as to secure any but the best results. Antiquated equipment together with guess-work methods of judging temperatures and treating the steel must be done away with because they result in inefficient or spoiled work, the cost of which may often equal the entire cost of the right kind of equipment. Money can be saved in many shops by the installation of modern forging, annealing, carburizing and heat treating furnaces; also the temperature control apparatus, pyrometers and other equipment necessary for their efficient operation.

COMMUNICATIONS

PIECEWORK AND PRODUCTION

Roselle Park, N. J.

To the Editor:

The article in the July issue of the *Railway Mechanical Engineer* entitled "Piecework Needed to Increase Production" has been sharply criticised by the railway shop crafts on the ground that it misrepresented the American workman and advocated obsolete methods to increase production. The writer had no such intention, well knowing that when compared with the workers of other countries, the American workman excels in many ways, as was forcefully proved during the recent war.

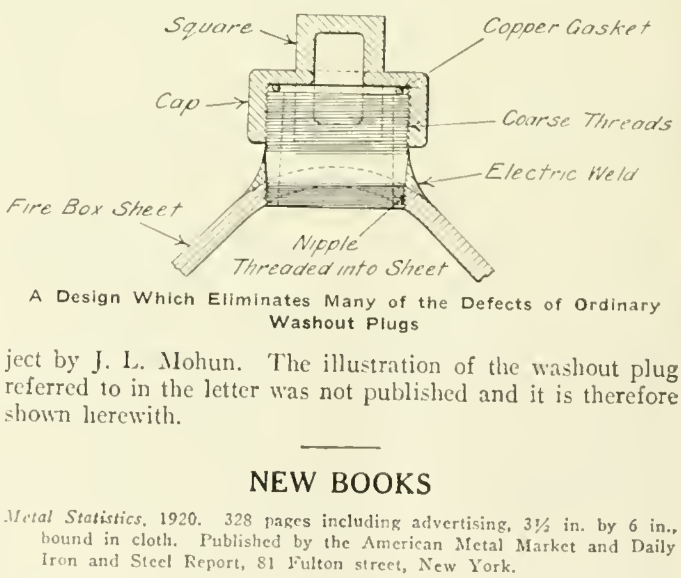
Regarding the piecework system, the underlying idea was simply that special skill and ability should be specially rewarded or compensated for, which in the writer's opinion could be best accomplished by a proper bonus system. However, since any system in order to be a success must be agreeable to the railway shop crafts, otherwise no co-operation on their part could be expected, it logically follows that the piecework system, being objected to by the majority of them, cannot be considered.

The most essential thing today in railroad shops is co-operation between the officials, supervisors and shop crafts. This, combined with loyalty to service will bring out inventive genius and constructive ideas on the part of the mechanics and supervisors.

Frank J. Borer.

HANDHOLDS VS. WASHOUT PLUGS

In the September issue of the *Railway Mechanical Engineer* on page 567, there appeared a letter on the above subject by J. L. Mohun. The illustration of the washout plug referred to in the letter was not published and it is therefore shown herewith.

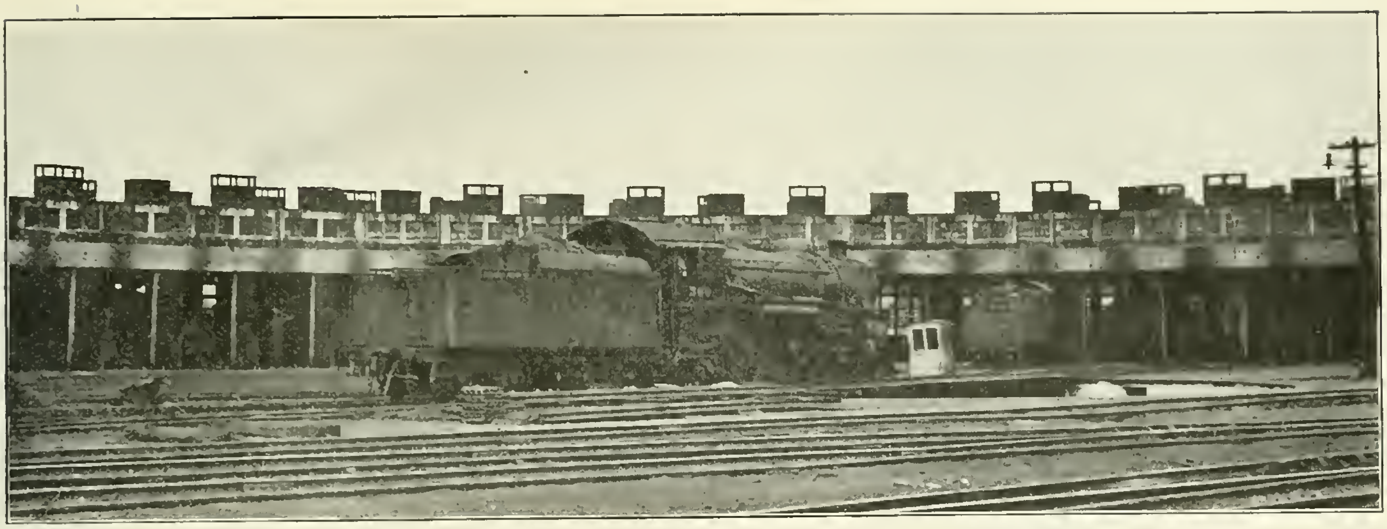


A Design Which Eliminates Many of the Defects of Ordinary Washout Plugs

NEW BOOKS

Metal Statistics, 1920. 328 pages including advertising, 3½ in. by 6 in., bound in cloth. Published by the American Metal Market and Daily Iron and Steel Report, 81 Fulton street, New York.

This book probably contains the most complete data concerning metal prices and production for many years past that is available in the form of a pocket handbook, and as such the book may be recommended to railroad purchasing agents concerned with metal purchases; although in the present erratic state of the market for all basic commodities, a study of previous price fluctuations would not appear to be of much value as an index to future price levels. The book does not contain any technical information relating to metals. does not contain any technical information relating to metals and is in no sense of the word a text book on metallurgy to be used by students.



Traveling Engineers' Association Convenes

Well Attended Meeting Discusses Operation of Stokers, Draft Appliances and Many Other Subjects

THE Traveling Engineers' Association held its twenty-eighth annual convention at the Hotel Sherman, Chicago, September 14 to 17, 1920. Following the opening exercises the President's address was delivered by G. A. Kell, (Grand Trunk).

Address of President Kell

President Kell spoke in part as follows:

During the great war special efforts were made by each and every man employed in the operation of railroads to conserve coal in particular and to operate the railroads at the lowest possible expense. In this the traveling engineer took no small part. Many of our members have been called on to take up important positions in connection with this matter.

It is just as important today to save coal and supplies as it has ever been. The cost of coal, oil, and supplies of all kinds is greater today than it has ever been before. Therefore there should be no relaxation on our part in any way, but every effort should be put forth to get more skillful operation of the locomotives on the road.

The drastic labor conditions that prevail throughout the country are the cause for great anxiety. There is social, racial, and industrial unrest everywhere, brought about to a great extent by the spirit and practice of profiteering and the high cost of living. Strikes have taken place; in some cases they have been due to over zealous, self-appointed labor leaders more than to anything else. The traveling engineers, whose conservatism and loyalty have never been questioned, who are scattered throughout the different parts of the country and who come in contact with a great many railroad employees, can do much toward influencing the rank and file of the men toward taking the right view of the present critical conditions. If ever there was a time in the world's history when calm and cool judgment should be exercised, now is the time.

OPERATION AND MAINTENANCE OF LOCOMOTIVE STOKERS

Because the stoker is comparatively new to the men, the organization of proper terminal inspection forces has been neglected on many roads. It is considered sufficient to assign a few mechanics to the task of working up the reports made out by the engine crews. A great deal of essential work is reported by the engine inspectors which was not found by the enginemen, and it is but natural to assume that without an inspection of the stoker by a competent inspector this machine will be allowed to continue in service many trips when in need of repairs. The stoker inspection force should be modeled along the lines of our present air brake inspection, and when this is done we will notice a large decrease in the number of so-called stoker failures.

There should be a man at each terminal who is held personally responsible for the condition of all stokers, and he should have a sufficient force of mechanics under his supervision to properly maintain and inspect the number of stokers handled. We can never hope to give stokers the attention deserved while we depend on a busy roundhouse foreman to give them what attention he is able to spare from his other duties.

When an engine arrives at the terminal or cinder pit track, there should be an inspector whose duty it is to run the stoker and observe all features of its operation, both from a mechanical viewpoint and also the manner in which it performs its various functions in order that any defects existing may be corrected before the engine is called to leave. Inspections which are left to be performed on the outgoing track often mean defects, cannot be corrected without delaying the engine, and as a result the engine is permitted to go without the work being done.

In most cases many important parts of the stokers are placed below the engine deck, and no attention is paid to the accumulation on them of coal and grease, with the result that it is nearly impossible to determine just what the machine looks like. If the machine is allowed to become buried, the roundhouse forces have good grounds for presuming that it is not of much importance and they lose interest in its upkeep.

MAINTENANCE

On the question of maintenance organization your Committee does not feel that any fixed rules can be laid down, as this is a matter which must be determined by local conditions and the number of stokers in service. The one vital point is that the organization must be such as to assure the maintaining of the stokers in good operating condition at all times.

Power being the first essential to operating the stoker, the

power plant should not be allowed to get in condition where it cannot furnish ample power to operate.

On stokers using fixed distributors it is essential that these be maintained to their original design, and not be allowed to become burned off, as under these conditions proper distribution of coal over the grates cannot be obtained.

On stokers using a movable mechanical distributor it is equally important that this be kept in good condition, and lost motion not allowed to develop.

When an engine goes into the shop for heavy repairs, the stoker should be removed from the engine and receive the same careful attention and overhauling which other devices get at such times, in order that when the engine is returned to service the stoker will be physically fit for the arduous duties it is called upon to perform.

G. A. Kell—Grand Trunk
President

Wm. E. Preston—Southern
1st Vice President

L. R. Pyle—Locomotive Firebox Co.
2nd Vice President

W. O. Thompson—New York Central
Secretary

D. Meadows—Michigan Central
Treasurer

LUBRICATION

The practice of equipping stoker-fired engines with a separate lubricator for oiling the steam cylinder of the stoker engine has been tried out with success, and the Committee recommends that this receive consideration. It has been found that this method not only excites more interest on the part of the fireman in the care of the machine, but also is an education to him in the operation of lubricators which he will be called upon sooner or later to handle.

Many parts and bearings of the stoker depend on oil cups for their lubrication, these cups oftentimes having pipe connections to the parts affected. If these cups are allowed to be taken off of the engine or be lost, the parts will run without oil and before this is detected, will be worn to such an extent as to require renewal. Another very important feature in this connection is to see that pipes are not allowed to remain stopped up for many trips at a time or that pipes are allowed to run with leaks in them which prevent the oil getting to the bearings.

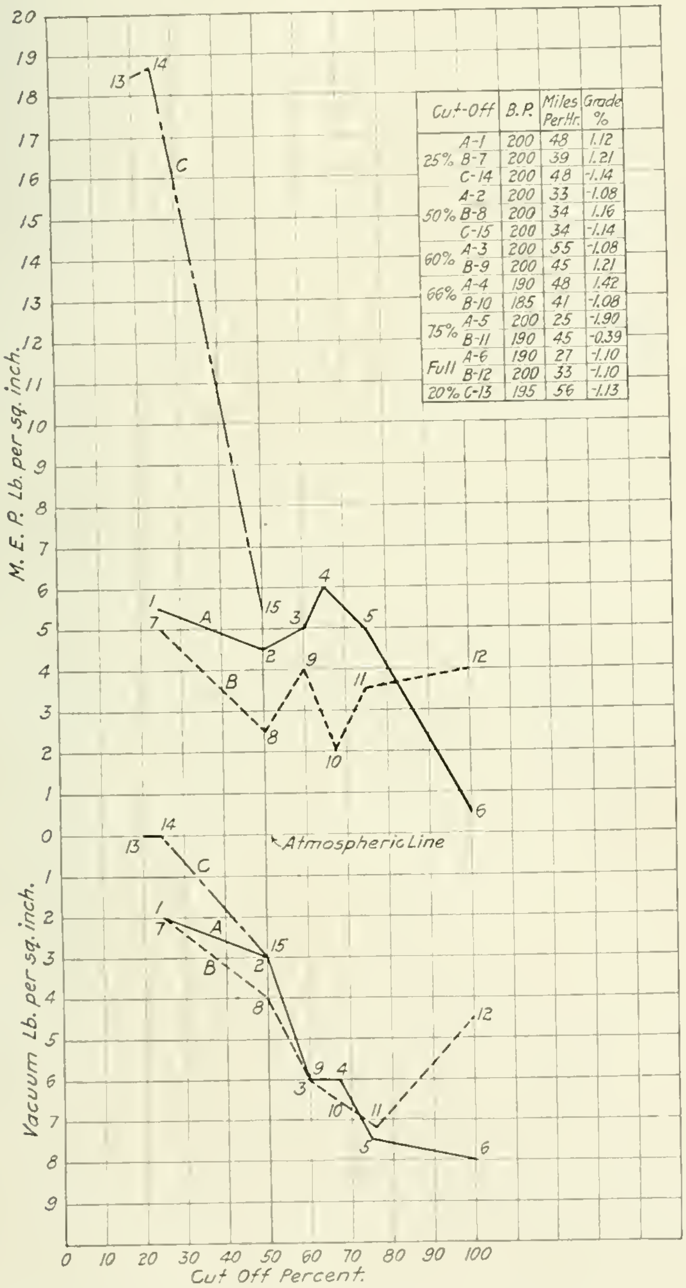
OPERATION

In the preparation of fires for the road, too much care cannot be taken in order that the stoker has a fire in proper condition on which to start firing. The stoker is only a machine, and not an automatic one. It will do only what it is made to do by human hands, so if the fireman starts it to work without having first put the fire in proper condition the stoker is in no way to blame for a poor performance. In the preparation of fires at terminals, hand firing only should be used. All banks should be leveled off by using the rake and the fire be allowed to burn through uniformly over the entire grate area before using the stoker. Many delays due to having to clean fires on the road are caused by no other reason than that the fireman did not get his fire in condition before starting and a clinkered fire was the result. Light fires are recommended for stoker-fired engines, but whether the fires are light or of medium thickness, it is necessary that they be burned uniformly over the grates before starting.

After starting, the fireman should endeavor to starve the conveyor trough whenever this is possible, as this will enable him better to observe any foreign matter which might enter the trough with the coal. Practically all firemen have been instructed and are practicing the art of starving the fire while the engine is working, and this method of firing has proven entirely satisfactory.

Firemen should be able to foresee the steam requirements

of their engines and maintain an even steam pressure with regular operation of the stoker, rather than run the stoker fast for a few minutes and then stop until the fire has burned through. The latter method is very wasteful of fuel. The use of the stoker to replenish the fire when rolling down grade, standing on passing tracks or when switching, should be discouraged, as the fireman should avail himself of these opportunities to become acquainted with the condition of his



Cut-Off		B. P.	Miles Per Hr.	Grade %
25%	A-1	200	48	1.12
	B-7	200	39	1.21
	C-14	200	48	-1.14
50%	A-2	200	33	-1.08
	B-8	200	34	1.16
	C-15	200	34	-1.14
60%	A-3	200	55	-1.08
	B-9	200	45	1.21
66%	A-4	190	48	1.42
	B-10	185	41	-1.08
75%	A-5	200	25	-1.90
	B-11	190	45	-0.39
Full	A-6	190	27	-1.10
	B-12	200	33	-1.10
20%	C-13	195	56	-1.13

Summary of Test Results Showing Vacuum and Mean Effective Pressure Obtained With Throttle and Drifting Valves

fire. Firemen should not be allowed to speed up the stoker in an attempt to build up certain parts of the fire but should use the shovel for this purpose.

When any foreign matter gets into the stoker the fireman should try to locate and remove it, rather than to try to force the obstruction through the machine.

When delivering an engine at the terminal all coal should be allowed to run from the conveyor trough and the slides should be closed in order that the engine will not be coaled with the slides in the back of the tender open and the trough become jammed with coal during this operation. The fireman should not wait until the engine is detached from the train and about to reach the cinder pit before closing the slides over the conveyor trough, for in this case he wastes the coal by putting it into the fire-box when it is not needed and makes the task of the fire knockers much harder than it would be otherwise.

Wonderful progress has been made in the economical handling of stokers in the past two or three years. The present-day stoker is efficient and economical in its performance when given the proper care and skillful handling.

The report was signed by I. T. Burney, chairman (Southern); O. W. Detrick, (L. V.); J. H. Harry, (Wabash); C. M. Freeman and W. A. Larick, (N. Y. C.).

Discussion

The lubrication of stokers was the point most generally discussed. Many of the members recommended the use of a separate lubricator for the stoker engine placed on the left side of the boiler head where it can be regulated by the fireman. While good results have also been obtained by the lubrication of the stoker engine from the main lubricator, the separate lubricator has the advantage of placing the entire stoker in the hands of the fireman, increasing his interest and preparing him for greater responsibilities on promotion.

In answer to questions which were raised as to the advantages of the stoker as compared with hand firing, the fact was brought out that in very few cases are hand fired and stoker fired locomotives of the same classes in service to permit directly comparable tests. While such tests as have been made by members of the Association indicate an increase in the coal consumption per locomotive mile this has been accompanied either by an increased tonnage, increased speed or both. In one case mentioned the increase in speed has been an important factor in reducing the average time of freight runs over the division from 15 and 16 hours to about 7 or 8 hours. The importance of carefully training stoker firemen was touched on by several members. The points most needing attention in this respect are care in cutting down the rate of coal feed to the minimum; that is, "starving" the trough, and the judicious use of the shovel in building up fires for the stoker and in keeping them trimmed. The reliability of the stokers now in service was quite generally testified to, very few failures occurring which are legitimately chargeable to the machine.

BY-PASS RELIEF AND DRIFTING VALVES

The subject covers three distinct appliances used on locomotives, all of which, though differently constructed, tend to serve practically the same purpose. This is the elimination of vacuum in the steam chest and cylinders and the prevention of the suction of smoke-box gases through nozzle tips into the steam chests and cylinders, which tends to destroy lubrication when the throttle is shut off and the engine drifting.

By-pass and drifting valves are used only on piston valve engines, while the relief valve is used with the slide valve as well as the piston valve.

Relief Valve

The relief valve opens direct communication between the steam chest and the atmosphere when the throttle is closed, admitting air into the steam chest at atmospheric pressure, this air being admitted to and exhausted from the cylinders the same as steam when the engine is drifting. In this way the vacuum created by piston action in the cylinders is destroyed.

On saturated engines, either of the slide or piston valve

type, this valve is of advantage for the reason that in its absence the vacuum created in the cylinders by the piston action would be filled with smoke and gases from the smokebox. It is well known what that means to lubrication. However, with the advent of superheat it was soon realized that air must be excluded from the steam chest and cylinders due to the high temperature developed in the steam chest and cylinders by the superheated steam. This valve is a detriment on superheated engines, except possibly on mountain roads where engines drift for miles at a time and are cushioned by means of the throttle. When the superheater damper is closed the engine will work saturated steam so where the damper can be regulated to drop with still enough steam to cushion the engine for some distance the saturated steam will soon cool the cylinders down so that the engine may be shut off. On long and heavy grades this will not only save fuel, but be a factor of safety that is worthy of consideration. When engines are cushioned by means of the throttle, it is essential that all lost motion be taken up in the throttle rigging and that it be sensitive so that the engineer can judge just what he is doing.

BY-PASS VALVES

There are a number of different types of by-pass valves, but practically all function the same. They are held closed by steam pressure when the engine is working steam, and when the engine is drifting the by-pass valve opens and establishes communication between both ends of the cylinders and the interior of the valve chamber, thus equalizing the pressure. Theoretically the principle of this valve is good, but experience shows that it does not always work out in practice, as the speed of the engine, the size of the cylinders and the area of the by-pass valves are factors that govern how effectively they fulfill the claims made in their behalf. The fact that they destroy compression, which many authorities on locomotives feel is essential to take care of the reciprocating parts when the engine is drifting, has caused some roads to discard them. However, there is a vast difference of opinion on the advantages and disadvantages of both the by-pass and the relief valve on piston valve engines; some roads are doing away with the relief valve and retaining the by-pass valve, others are doing just the opposite, others are doing away with both and still others retaining both.

DRIFTING VALVES

With the advent of superheat on locomotives it was soon realized that air must be excluded from the steam chests and cylinders. As a result, many forms of drifting valves have been developed and are now in use.

The function of the valve is to admit sufficient steam to the cylinders when the throttle is closed and the engine is drifting to prevent the formation of a vacuum in the steam chest and cylinders. Some of them are applied to the steam chest or steam channel, others to the cylinders direct; some are automatic and others are operated mechanically. In those applied to steam chests or channels, the steam admission to the cylinders is controlled by the main valve and if drifting is done at too short a cut-off the amount of steam admitted is of such a small volume that expansion may bring the pressure below that of the atmosphere, in which case a partial vacuum would be created which would tend to draw smokebox gases into the cylinders. Therefore it is better to have the drifting valve attached direct to the cylinders.

DRIFTING VALVE TESTS

The St. Louis-San Francisco ran a test of about 1,400 miles on a passenger engine having 26½-inch by 28-inch cylinders and 73-inch driving wheels over a 238-mile passenger division which has many heavy grades, making it necessary to drift the engine frequently. Two different types of drifting valves were used and a number of cards were also taken with the drifting valve shut off and the engine cushioned with the throttle.

Valve A is a homemade device. It consists of two differential pistons with a piston valve attached to the operating piston, which admits boiler pressure on top of the other differential piston when the engine is working steam, to keep this valve in closed position. When the throttle is shut off the differential valve with operating piston is moved up by boiler pressure under the small end of the operating piston. The movement of this differential piston allows steam to exhaust from the top of the second piston, raising it from its seat and allowing steam from the dome to pass into the steam chest. The size of the steam pipe from the dome to a point back of cylinder saddle is 1½ in., where it connects with a tee, and from this point to the drifting valve 1¼-in. pipe is used. The 1½-in. pipe has a globe valve at the dome. When the engine stops, steam is admitted to the top of the differential with the operating piston through a pipe connection in the steam chest, moving it down and carrying the valve with it. This admits steam on top of the second piston, closing the valve. This valve is supposed to work as soon as the throttle is closed.

Valve *B*, which is a commercial device, has similar steam pipe connections, with the exception that the pipe from the tee connection to the valves is 1 in., and it consists of one large differential piston. When the engine is working steam the differential piston is held down, covering the steam port opening from the pipe to the steam dome. When the throttle is shut off, the vacuum moves the differential piston, opening communication between the steam pipe and steam chest and allowing steam to pass direct from the dome to the steam chest.

On the chart the solid lines show the results obtained by Valve *A*, the dotted lines Valve *B* and the dash and dot the throttle drift. During the test Pennant valve oil was used. The lubricator was set at five drops per minute to each valve and one drop to the air pumps. The oil was measured at the end of the trip and it amounted to an average of three pints per trip of 238 miles or about 79 miles to the pint. Piston rods were watched closely during the test, always showing good lubrication. The cylinder heads were removed after the test of each valve and were found to be free from carbonization and well lubricated.

During the test with both types of drifting valves the throttle was shut off completely, the same as would be done with a saturated steam engine, anywhere the train would roll and make the time.

While there was not an indicator card taken that did not show some vacuum, it is evident from the way the engine was lubricated that there was an advantage gained by the use of either type of drifting valve. Further, it can be seen that the best results were obtained with both valves at a 25 per cent cut-off. At this cut-off the mean effective pressure was the greatest and the vacuum the least. The throttle drift at 20 per cent and 25 per cent cut-off showed no vacuum, but the mean effective pressure was rather high for good practice. The 50 per cent throttle drift shows a vacuum which indicates not enough mean effective pressure, demonstrating that where the throttle, its rigging or the engineer's judgment are not of the best, results are likely to go from one extreme to the other, either of which is detrimental.

A drifting valve must be so designed as to take care of the worst conditions that can arise, which is generally admitted to be a combination of high speed and short cut-off, as it is under such conditions that the greatest damage is done. A drifting valve to be effective should automatically close when the engine is working steam, automatically open the instant the throttle is closed, and automatically close when the engine comes to a stop. It should have as few working

parts as possible, and these should be properly cushioned or otherwise protected from shocks due to rapid fluctuations in pressure.

The report was signed by J. D. Heyburn, chairman (St. L.-S. F.); A. G. Newell (E. P. & S. W.), N. Suhrie (Penn.), W. Sharp (G. T.) and D. C. Dickert (Sou.).

Discussion

Considerable difference of opinion was expressed as to the cause of carbonization in the cylinders of superheater locomotives. While the flash temperature of the cylinder lubricating oils used with superheated steam is low enough so that carbonization might be expected when air is admitted to the cylinders following the closing of the throttle, as it would be through a release valve, the experience of some of the members seems to justify the opinion that, practically, carbonization is much more likely to be due to deposits from the front end gases drawn into the cylinders through the exhaust passages when drifting with neither relief nor drifting valve equipment.

The Whalen combined relief and by-pass valve was referred to and it was described by the inventor. Two of these valves are installed, one in pipe connections, leading from each port passage to the live steam cavity of the valve chamber. When drifting, the valve automatically opens the by-pass connection and at the same time opens a passage to the atmosphere, the area of which can be adjusted. The usual adjustment calls for 50 per cent by-pass and 50 per cent relief valve action. A service of two years has indicated a material saving in repairs to reciprocating parts and in cylinder packing renewals, and no difficulty has been experienced from carbonization.

Several cases were mentioned where comparisons between engines equipped with by-pass valves or relief valves and others unequipped have demonstrated the need for some such equipment. Without it cylinder packing, valve packing and rod packing all gave trouble while with it this trouble was eliminated and the life of the packing materially increased. The difficulty in lubricating the low pressure cylinders of locomotives when drifting was mentioned. Where using the drifting throttle it has been found that a reduced cut-off is necessary to permit the building up of sufficient pressure in the receiver to properly carry the lubricant into the low pressure cylinders.

The drifting throttle was the subject of much of the discussion. In fast passenger service on the New York Central it is the practise to ease off the throttle in making stops, but not to close it until the speed has been reduced to 15 miles an hour. Many back end main rod failures are attributed to the severe pounding resulting from a full closure of the throttle at high speed. Other members also advocated the drifting of all locomotives with steam admission, but this practice was objected to by others because of the difficulty of properly regulating it. In closing the discussion, J. B. Heyburn, chairman of the committee, commenting on the practice of drifting with steam admitted through the main throttle, did not question the ability of some men to get good results, but considered that the average man is not sufficiently skillful to do so. He therefore advocated the development of some form of drifting valve which would operate automatically.

WHAT ARE THE MOST SUITABLE DRAFT APPLIANCES?

The most suitable draft appliance is that which will produce the required draft with least back pressure under the varying conditions of locomotive operation. That such draft be developed uniformly is greatly to be desired in order that cinder losses may be reduced and the mixture and chemical union of gases in the fire-box improved, and also because the peaks or maximum efforts of intermittent draft are largely responsible for the plugging of flues; the loss in superheat caused by obstruction to the flow of gases in the superheater tubes frequently being as high as 32 per cent.

Development of draft apparatus which gives promise of approximately complying with these requirements has been under way during the past year or two and should be encouraged; but for the immediate need we must confine our efforts to the fixtures at hand or easily obtainable. The required draft in many instances is less than that which will develop the maximum evaporation. Engines in switching service or regularly in light work of other nature may often be run successfully with draft appliances which demand less back pressure than would be required if the same engines were engaged in more severe continuous work.

While the cinder losses will average approximately 6 per cent of the fuel burned, these losses frequently increase to from 18 per cent to 23 per cent during the period of maximum effort. However, the amount of fuel used per unit of work done decreases rapidly and consistently as the tonnage per train increases toward a reasonable maximum. Therefore, in general, the draft appliance should be so constructed as to provide for satisfactory performance at maximum capacity of each locomotive, and fortunately such arrangement will be found as generally satisfactory as is possible with present apparatus during periods of lighter work.

Section III Committee Report

Results of a series of nozzle tests were recorded briefly in the report of the Committee on Fuel Economy and Smoke Prevention at the June convention of the American Railroad Association, Section III, Mechanical.*

This committee summarized the results of these tests and its conclusions as follows:

"They indicate that under the conditions peculiar to this test with a nozzle having four internal projections it was possible to obtain a higher equivalent evaporation per hour with less back pressure than with a circular or rectangular nozzle having approximately the same net area.

"Your committee does not consider the information now available sufficiently complete to justify positive conclusions as to the most efficient shape of nozzle, and is only in position to report that the circular form of nozzle does not result in the highest vacuum and the least back pressure. As to what form will produce those conditions it is impossible to say without an extended investigation involving a long series of test plant observations.

"It seems evident, however, that all preconceived ideas of exhaust jet action must be revised to agree with the apparent fact that the best results will be obtained when the jet contour is interrupted, as is the case both with the internal projection nozzle and with the one having one axis longer than the other."

The increased draft obtainable by use of the four internal projection nozzle is said to be due to the increase in gas entraining capacity which results from breaking up the continuity of outside of exhaust steam column, thus increasing the surface of the steam jet with which the smoke-box gases may come in contact and promoting the intermingling of these gases with the steam jet.

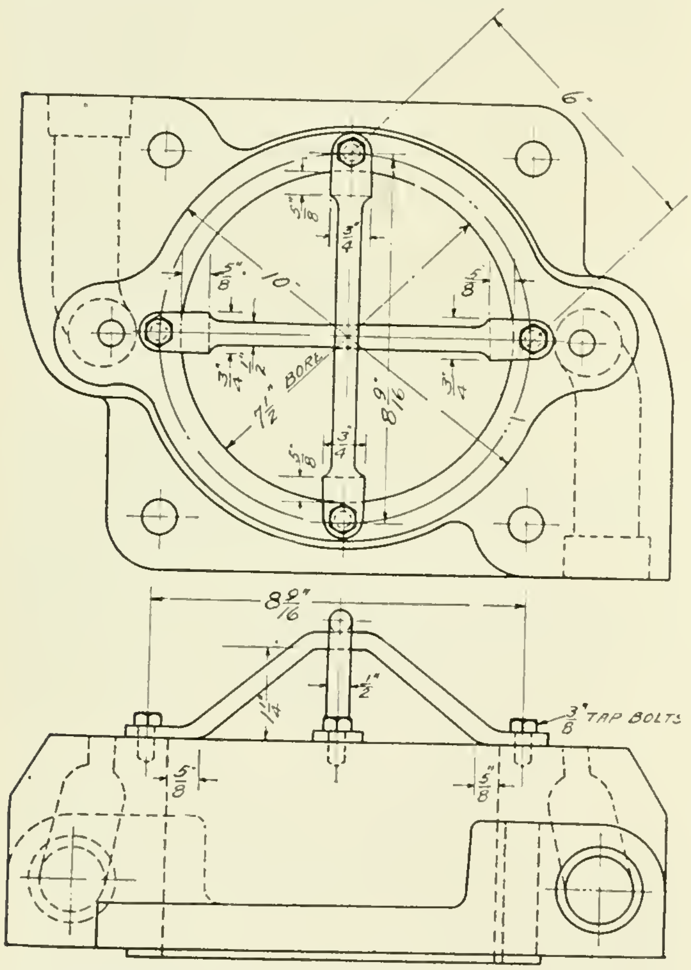
Indicator cards taken during tests with the internal projection nozzle illustrate clearly that at low temperature the steam does not flow so rapidly as at higher superheat, that with low superheat there is higher back pressure and also a lower initial cylinder pressure even when the steam chest pressure is higher for low superheat than for high superheat. This increase in rapidity of flow due to superheat accounts for the "snappier" exhaust of the superheated locomotive; and as the amount of draft depends, among other conditions, on the length as well as the speed of exhaust jet, it might appear that a reduction of nozzle size should

*See the *Daily Railway Age* for June 11, 1920, page 1705.

accompany the superheating of a locomotive. However, this has not been found necessary in many instances and a conclusion that draft appliance details, including size of nozzle tip, when most suitable for locomotive using saturated steam, should not be changed when superheating apparatus is installed, is sustained by carefully conducted tests at the Pennsylvania Railroad testing plant at Altoona. We are justified, therefore, in using smaller nozzles with superheated steam than were most suitable for saturated steam only as a last resort.

The Basket Bridge Nozzle

Attention is also invited to the nozzle tip arrangement in use on a large number of New York Central locomotives which consists of the usual circular nozzle provided with a so-called "basket bridge," consisting of two splitters set at right angles with each other with the point of intersection directly over the center of nozzle, the splitters being arched



Basket Bridge Exhaust Tip Used by the New York Central

to 1¼ in. above the tip at the center. This device is giving very satisfactory service, the use of splitters so arranged having made it possible to increase the effective nozzle opening very materially above the required opening of the plain circular nozzle tip. Engines so equipped give splendid performance, both from capacity and fuel economy standpoints.

N. & W. Tests

In the June, July and August, 1918, issues of the *Railway Mechanical Engineer*, there appears a series of articles written by H. W. Coddington, engineer of tests of the Norfolk & Western, giving accurate and valuable information obtained from extensive tests under most carefully arranged conditions in road service. The experiments indicated clearly the possibilities for improvement in draft and locomotive performance by variation from the standard practices and appliances which have been in use for years. These tests also show conclusively that by increasing the external surface of the exhaust column, thus affording greater opportunities for contact of this steam column with the front end gases, that material improvement in draft and locomotive performance can be obtained.

The results recorded were obtained during tests with Norfolk & Western engine No. 100, class "K-1" 4-8-2 type. The original nozzle was 7 in. in diameter with 9⅜-in. splitter, and a free area of 35.86 sq. in., 18-in. stack and 26½-in. inside extension. As a result of experiments the stack was changed to one of 24-in. in diameter, with 26½-in. extension and 14-in. diameter annular waffle iron nozzle, with effective area of 49.35 sq. in. The steaming capacity was improved; exhaust pressure with the circular nozzle and splitter was 10.94 lb., with the waffle iron nozzle, 4.54 lb.; front end draft with the circular nozzle and splitter was 8.91 and with the waffle iron nozzle 8.63 in. of water, and the locomotive under the decrease in back pressure developed approximately 140 additional horsepower. Using the very conservative figure of 5½ lb. of coal per indicated horsepower per hour, this shows a possible saving of 770 lb. of coal per hour, while the locomotive is working at the rate maintained during the test runs.

Mr. Coddington very recently advised us that the front end arrangement described has been applied to the U. S. R. A. Mountain type locomotives, N. & W., class K-2, with as great resultant benefit as was observed in the K-1 class.

The Theory of Draft Action

Supplementing the conclusions on this subject, as stated by the Committee on Fuel Economy and Smoke Prevention, it seems that any change from the plain circular periphery of the steam jet increases its efficiency in producing draft; one reason for this is that a circle being the shortest possible boundary for any given area, if the cross section of the steam column between the nozzle and stack is circular, the column will have less surface area than it would have if its cross section was any other form. The gas "entrainment" theory is supported by all investigation. However, during the Norfolk & Western tests it was found that the best results were obtained when the exhaust steam column struck the sides of the stack 38 in. or 70 per cent of the length of stack, including the extension, below its top. Every traveling engineer knows that when the exhaust does not essentially fill the stack at the top there is a down draft at the locality not filled and therefore both the so-called "entrainment" and piston action assumptions must be considered when studying this most interesting and important matter.

The expulsion of air and gases from the smoke-box by means of a steam jet directed up the stack is accomplished by the steam jet, either blower or exhaust, forcing (not pulling) air and gases through the stack. A steady flow of steam out the exhaust nozzle or blower will produce draft because the outside surface of the expanding column is broken up irregularly into numerous sections or jets which engulf within the column as a whole and pocket against the sides of stack many small portions of the gases in smoke-box or stack, and thus by pushing innumerable small quantities of smoke-box gases out the stack in this manner reduce the smoke-box pressure.

The Multiple Nozzle and Stack

It appears that the Norfolk & Western has gone farther in the right direction than the other experimenters, at least in so far as applications in service are concerned, but in stack investigation they varied only the diameter of the stack and extension and the length of stack extension inside the smoke-box, and they got best results from the longest extension used. Developments made by William Elmer of the Pennsylvania are therefore of special interest. He found by a

long series of tests that best results in draft production, by means of a steam jet issuing from a circular nozzle tip, were obtained when the diameter of conduit or stack was 3.1 times the diameter of nozzle and when the length of conduit or stack is from five to six times its diameter and when the jet first filled the conduit at about the center of the conduit. Obviously, it is impracticable to provide a modern locomotive with a stack from 10 to 12 ft. long, but by exhausting through several nozzle tips suitably placed below a stack containing a nest of conduits he was able to accomplish a working basis for the desired dimensions within clearance limits and to increase the effective nozzle opening 30 per cent as compared with that of the largest single circular nozzle which it had been possible to use. The multiple nozzle and stack also materially increase the draft.

It does not require exhaustive thought to determine that a stack can be too short and that a stack can be so long that friction of gases and steam within it will detract from the benefits derived by having just enough stack length. The multiple nozzle and stack design provides a method for equipping modern locomotives with stacks of sufficient diameter and length and it also provides for an extensive increase in the surface of the exhaust steam column between the nozzle tip and stack as well as for a very material increase in effective nozzle opening.

Some most interesting experiments conducted by the mechanical department of the Big Four during the past year indicate the advisability of maintaining the same average exhaust pressure while a locomotive is operating at maximum capacity during the entire range of speeds, and they have equipped at least one locomotive with apparatus which automatically adjusts the cut-off so as to maintain a predetermined exhaust pressure at all speeds. It is not the intention to discuss this invention, but we urge the installation of back pressure gages on all road locomotives, as knowledge of this pressure will not only aid greatly in improving draft conditions and apparatus, but will enable the engineers to operate locomotives more efficiently.

Distribution of Draft Through the Grates

Even a most efficiently developed draft in the smoke-box will only partially obviate some of the present losses and inefficiency, unless that draft is most advantageously distributed throughout the fire-bed. Use of the so-called checkered arch appeared to be a move in the right direction, but difficulties have arisen in connection with its general use. The standard arch, as usually applied, causes the draft to be applied most severely through the back grates and, to avoid the ill effects of excess air through this section of the fire-bed, firemen have resorted to excessively heavy firing on the back gates. We have decried such practice as wasteful—perhaps without entire justification under the existing unequal distribution of draft.

Draft deflector plates below the grates or variations in air inlet openings through the grates so as to equalize or properly distribute the draft through the fire, seem to be required when the standard arch is used, but because of the difficulties which would be encountered in following either of these suggestions, suitable changes in the location of arch bricks or the reduction of air openings through the rear grates are recommended—preferably the former, for we fully appreciate that the best performance demands the maximum possible opportunity for air to pass through the grates.

The report was signed by H. C. Woodbridge (Loco. Stoker Co.), chairman; W. G. Tawse (Loco. Superheater Co.), W. M. Cooper (Grand Trunk), H. L. Harvey (C. & N. W.), and T. L. Kenney (Big Four).

Discussion

Several members were disposed to question the statement in the report made in referring to the checkered arch, that the standard arch is the cause of the apparently heavier draft at the back end of the grates, this being explained as due to the tendency for a heavier fire to accumulate at the front end of sloping grates and to the openings at the rear ends through which the grate rigging passes which provide for greater air admission under the rear end of the grate than at other portions. Some difference of opinion was expressed as to the advantages of the checkered arch, although in one case where comparative tests have been made and the coal measured, the fuel consumption has been found to be less with the checkered arch than with the standard arch. The former has also proved advantageous in reducing smoke on switch engines in terminals. The statement was made in the discussion that the basket bridge used on the New York Central in one case made possible an increase in the size of nozzle opening from 5½ in. to 6⅝ in. and that wherever it has been used it has resulted in a reduction in fuel consumption.

The discussion showed a feeling among many of the members that an exhaustive investigation of front end designs in which all factors should be taken into consideration, was very much needed.

In closing the discussion Mr. Woodbridge laid stress on the value of the installation of a back pressure gage in the cab, connected through branch pipes to the exhaust passages of the cylinders. This has been found of value in comparing the draft efficiency of different engines and in providing the engineman with a check both on draft conditions and on his handling of the engine.

THE NICHOLSON THERMIC SYPHON

BY HARRY CLEWER
Fuel Supervisor, Chicago, Rock Island & Pacific

The first application of the Nicholson-Thermic Syphon equipment to a locomotive was made more than two years ago on the Chicago, Milwaukee & St. Paul; this road since then has equipped four more locomotives.

About sixteen months ago the Chicago, Rock Island & Pacific equipped two locomotives, one superheated and one non-superheated, after which an extended and thorough test of this equipment was conducted, comparing these engines with others of the same class but without the syphons.

Test results and subsequent developments in service were of such a favorable nature that a program has been established of equipping ten engines a month in the shops. In addition to this, thirty-five new Mikado, Santa Fe and Mountain type locomotives now building will be equipped with syphons. This will make a total of 75 locomotives equipped.

Comparative Summary of Tests of Superheated and Saturated Locomotives, With and Without Nicholson Thermic Syphons.

Locomotive number Description	2057 Saturated, arch tubes and arch	2062 Saturated, syphons and arch	2021 Superheated, arch tubes and arch	2039 Superheated, syphons and arch
Pounds coal per locomotive mile....	262	220	195	166
Pounds combustible per locomotive mile	206	168	150	128
Pounds coal per 1,000 gross ton miles, adjusted	129.3	108.1	80	68.7
Pounds combustible per 1,000 gross ton miles, adjusted........	101.7	82.0	62.8	52.8
Equivalent evaporation per lb., dry coal	6.84	7.62	8.06	9.14
Equivalent evaporation per lb., combustible	7.85	8.94	9.33	10.71
Boiler efficiency—percentage........	56.26	63.20	65.34	74.18

It is possible to increase fire-box heating surface from 10 per cent to 40 per cent, depending upon the number and size of syphons used. One, two and three are used, depending upon the width of the box. The syphons form two to four combustion chambers in the hottest part of the fire. This leads to a much better mixture of the liberated gases and air, thus aiding complete combustion. The syphon heating surface is in a position to "see" the fuel bed and flame,

so the transfer and heat to the syphon by radiation is high.

Intake channels enter the neck of the syphon at the throat sheet and extend along the barrel of the boiler nearly to the boiler check. They are simply inverted troughs capable of delivering to the syphon all of the water which will be discharged through the crown sheet opening.

The Rock Island tests showed that the two-syphon equipment on a consolidation locomotive increased the evaporation 14 per cent per pound of coal. A summary of the tests is given in the table and all indications on locomotives equipped since the tests were conducted, verify the test results.

The syphon equipment does not disturb the water level in the water glass. It was noticeable during the tests referred to that the water in the glass was very quiet.

The intake channels do not clog and the scale formation is no greater in the syphon than on the sides and crown sheets. Well located washout plugs make it possible to wash the syphons thoroughly.

Next Year's Officers

The following officers were elected to serve for the coming year: President, W. E. Preston (Sou.); first vice-president, J. H. DeSalis (N. Y. C.); second vice-president, F. Kerby (B. & O.); third vice-president, E. H. Howley (Erie); fourth vice-president, W. J. Fee (Grand Trunk); fifth vice-president, J. N. Clark (Sou. Pac.), and treasurer, David Meadows (M. C.). The following are the new members of the executive committee: J. D. Heyburn (St. L.-S. F.); J. E. Russell (Sou.), and V. C. Randolph (Erie).

Government Tests Of Water Indicating Devices

Report of Final Tests and Recommendations Submitted by The Bureau of Locomotive Inspection*

For the purpose of determining, if possible, the general outline of the flow of water which evidently existed at the back head, when high evaporation was taking place, tests were made on one of the U. S. Railroad Administration standardized 2-10-2 type locomotives, equipped with five arch tubes and brick arch, extending to within 51 in. of the door sheet; fired with duplex stoker and using bituminous coal for fuel. The test apparatus used in these tests is of the boiler. It was found during these tests that with the top connection to the water column connected at its original position the column would entirely fill when 4 in. to 5 in. of water was reached in the column glass. When changing from this connection to the highest point on the back head, the water would immediately recede to 4 in., but when changing from one connection to the other on the highest part of the boiler the readings were not affected, which in-

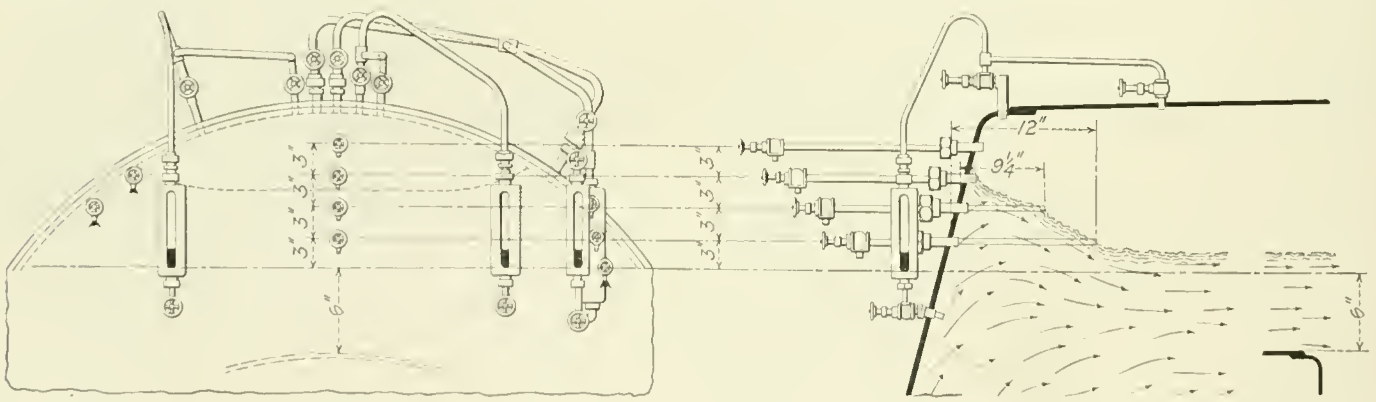


Fig. 3—Water Indicating Devices Used in Fourth Series of Tests

shown by Fig. 3; the sliding tubes illustrated were graduated so that correct readings could be taken.

Fourth Series of Tests

During two round trips many readings were taken while the locomotive was in operation. It will be noted, by referring to Fig. 3, that with 2 in. of water showing in all glasses and one gage of water in the column, the gage cocks applied on the left side of the boiler head in the usual manner indicated full water, while No. 1 tube indicated strong flutter at a 12-inch adjustment, No. 2 tube indicated a strong flutter at a 9¼-inch adjustment, and No. 3 tube showed an occasional flutter at the back head, showing a rise of water at the back head of approximately 9 in. above that being registered by the water glasses or existing further ahead over the crown sheet.

The dotted line in Fig. 3 indicates what we believe to be the general outline assumed by the water where it reaches a greater height on each side than at the vertical center line dicated that dry steam was being obtained both at the back knuckle and further ahead, which was, no doubt, due to the increased dry steam space in the back end of this boiler and the exceedingly good water used in this district.

Fifth Series of Tests

To further determine the approximate outline and proportions of the water conditions existing at the back boiler head, while the locomotive is being operated with heavy throttle, or when steam is being rapidly generated and simultaneously escaping from the boiler, tests were made with appliances shown by Fig. 4, covering a distance of 808 miles, in bad-water districts, on approximately level track and while handling regular tonnage.

The locomotive on which these tests were made was of the heavy 2-8-2 type, equipped with superheater and Duplex stoker, using bituminous coal for fuel. The boiler had a sloping back head, with firebox equipped with brick arch supported by four 3-inch arch tubes, the brick arch extending to within 52 in. of the door sheet and 30 in. of the crown sheet.

The apparatus shown by Fig. 4 consisted of four gage

*The preceding portion of this account of tests recently conducted by the Bureau of Locomotive Inspection of the Interstate Commerce Commission was published in the September issue of the *Railway Mechanical Engineer*.

cocks applied directly in the back head near the knuckle, one water column to which three gage cocks and one water glass were attached, one water glass with a 9-inch reading, standard application, with both top and bottom cocks entering boiler back head direct, one water glass applied for experimental purposes with the bottom cock entering the boiler head on back knuckle and one entering 13 in. boiler head on back knuckle and one entering 13 inches ahead of the back knuckle, and four exploration tubes or sliding gage cocks.

Fig. 4 shows a side elevation of these exploration tubes or sliding gage cocks entering the back head parallel to the horizontal axis of the boiler through suitable stuffing boxes, with a vertical pitch of 3½ in., giving a total vertical reading of 10½ in. with a horizontal adjustment of 24 in. Gradations were marked on these tubes so that accurate readings could be taken and recorded. The lower one of these tubes entered the boiler head on a level with No. 2 gage cock. The lowest reading of all water glasses and gage cocks was 4⅝ in. above the highest point of the crown sheet.

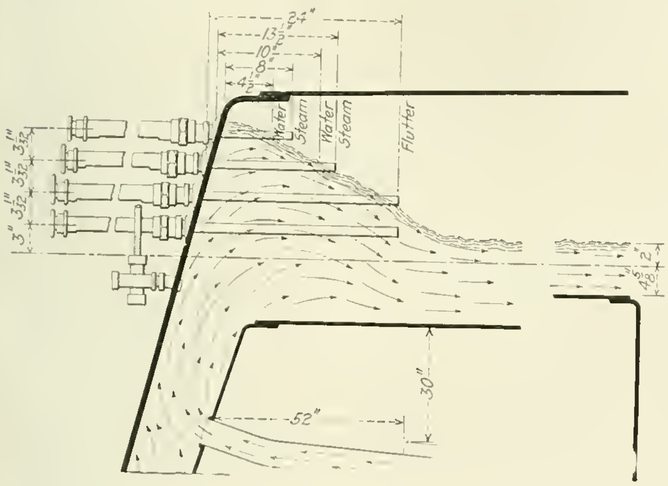


Fig. 4—Water Indicating Devices Used in Fifth Series of Tests

It will be noted from Fig. 4 that while tube No. 1 was submerged, tube No. 2 showed a flutter of steam and water at an adjustment of 24 in.; tube No. 3 showed water at an adjustment of 10 in and steam at 13½ in.; tube No. 4 showed water at an adjustment of 4½ in. and steam at 8 in. These readings were taken while the experimental water glass and water glass attached to the water column registered 2 in. of water, and the gage cocks attached to the water column showed one gage, while the four gage cocks applied in the back head registered full.

The water in the territory where these tests were made is very light and foams badly when compound is not used. About 110 readings were taken with these tubes or sliding gage cocks and other appurtenances used to register the water level. It is impossible to outline this flow of water accurately, as it changes with the operating conditions and the condition of the water in the boiler; but it is believed that this serves to illustrate the general condition which prevails to a greater or less extent in all locomotive boilers, especially those equipped with brick arch and arch tubes, while the locomotive is working heavy throttle or steam is rapidly escaping from the boiler.

It was found that approximately the same conditions were disclosed as those developed in other tests, except that the outline of water reached a higher elevation and greater proportions at the back head than those illustrated by Fig. 3, which is, no doubt, due to the extremely good water used for locomotive purposes in the district where the previous tests were made.

The readings of the water column and experimental water glass could not be varied when changing from one connection to the othe:, as was the case in other tests, which we believe was due to the increased steam space in the back end of this boiler; and while the roll of water up the back head reached at times an approximate height of 12in. to 13 in. above the general water level in the boiler, it did not apparently reach the top connection to these appliances in the back head knuckle.

When foaming very badly, there was slight agitation in the experimental glass when connected in the back knuckle, and occasional bubbles in the glass, but not sufficient to attract serious attention. This agitation was entirely absent when the top connection was made ahead of the back knuckle. With 1 in. of water, or less, the water in the standard glass registered practically the same height as the other two glasses. With 2 in. to 2½ in. of water in the glass, when water was foaming, the water in the standard glass rose 2 in. to 3 in. higher, and there was much agitation and many bubbles in it, while the column glass and the experimental glass connected ahead showed no agitation whatever. With 3 in. or more of water in the standard glass and the water foaming badly, the standard glass would fill, and it was impossible to tell the actual height of water in the boiler by that device without closing the throttle, while the experimental glass and the glass attached to the column continued to register 3 in. or more of water, and the top gage cock, attached to the column, would indicate dry steam when opened in the usual way, and the four gage cocks applied directly in the boiler would register full water.

Observations Made with Light in Boiler

Tests were made on a comparatively small locomotive, used in switching service, equipped with a wagon-top, radial-stayed boiler, having narrow OG firebox and vertical back head, the diameter of the largest course being 59 in. The special feature which should be borne in mind is that no arch or arch tubes were used in this boiler and that the back head was vertical.

The water-indicating devices consisted of three gage cocks spaced 3 in. apart and applied directly in the right knuckle of the back boiler head, with a vertical reading of 6 in., and one reflex water glass with a clear reading of 7 in., and with top and bottom connections entering the boiler head direct on the vertical part 5 in. to the right of the center line. The lowest reading of the gage cocks and water glass was 3 in. above the highest part of the crown sheet.

So that the action of the water could be observed, a glass tube was inserted in the top of the wrapper sheet which permitted the use of an electric light inside the boiler, which clearly illuminated the steam space over the crown sheet. Five bullseye sight glasses were applied over the back end of crown sheet, two over the front of crown sheet and three in the vertical back head, so that the action of the water in this part of the boiler could be seen while under steam pressure. The arrangement of these appliances is illustrated by Fig. 5.

Both main rods were disconnected, cross heads blocked at end of stroke and valve stems disconnected and so placed that steam was discharged through the exhaust nozzle and stack, creating a forced draft on the fire, representing as nearly operating conditions as possible.

When the throttle was closed and no steam escaping from the boiler, the surface of the water was approximately level, with a distinct circulation noted from back to front and from the sides toward the center of the crown sheet. When the safety valves lifted, the water rose with fountain effect, around the edges of the firebox, from 1 in. to 2 in., and the circulation was materially increased.

When the throttle was opened and steam was being generated and escaping from the boiler in greater volume, the level of water throughout the boiler was seen to rise 1 in. to

1½ in., which rise was registered by the water glass. and a marked flow of water, with fountain effect, was observed rising around the firebox at the back head and wrapper sheets, reaching a height above that over the remaining portion of the crown sheet of approximately 2 in. to 4 in., in proportion to the amount of steam being generated and simultaneously escaping from the boiler.

The important feature to be noted is that this height of water, as seen at the back head, was approximately 4 in. at its maximum, and was registered by the gage cocks, while at the same time it could be seen that the water glass was registering the level further ahead over the crown sheet.

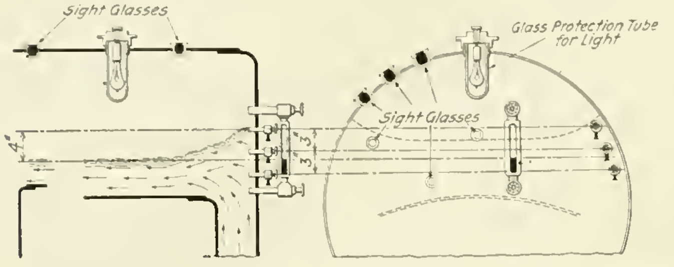


Fig. 5—Arrangement of Light in Boiler to Determine Water Conditions

Among the interesting features observed were the size of the steam bubbles which were approximately ¼ in. to ⅜ in. in diameter, and the rapidity with which they were seen to rise to the surface and explode. The size and number of these steam bubbles, which were seen rapidly rising next to the back head, explain one of the physical reasons for the increased height of water around the crown sheet and the rapid circulation attained.

These observations establish beyond question that when steam is being generated and escaping there is an upward movement of water at the back head of the locomotive boiler which carries it above that further ahead over the crown sheet, and that the gage cocks, when applied directly in the boiler, register this rise of water and do not indicate the level further ahead, while the water glass registers the level of water further ahead and not the fountain of water at the back head.

Since a difference of 4 in. was observed between the height of water at the back head and that further ahead in this boiler, which had a vertical back head and OG type firebox and was not equipped with brick arch or arch tubes, there can be little question but that in the modern locomotive boiler, which has a sloping back head and is equipped with brick arch and arch tubes, which greatly accelerates the movement of water in this part of the boiler, due to the rapid circulation through the arch tubes and the deflection of heat against the door sheet and back end of crown sheet by the brick arch, this difference between the height of the water at the back head and further ahead over the crown sheet must be materially increased.

General Observations

The feed water which enters near the front end is much lower in temperature than that in the boiler, which, due to its density and weight, naturally lowers and moves toward the firebox sheets where the greatest evaporation takes place. As the water is heated it rises, due to its decreased weight, influenced by the steam bubbles rising to the surface where they explode. This circulation causes a movement of water from front to back in the lower portion of the boiler, and upward around the firebox, and from back to front in the upper portion. This circulation unquestionably takes place with sufficient rapidity to carry the water in the boiler around the firebox sheets above the general water level, due to the limited space in the water legs, where the greatest amount of heat is applied.

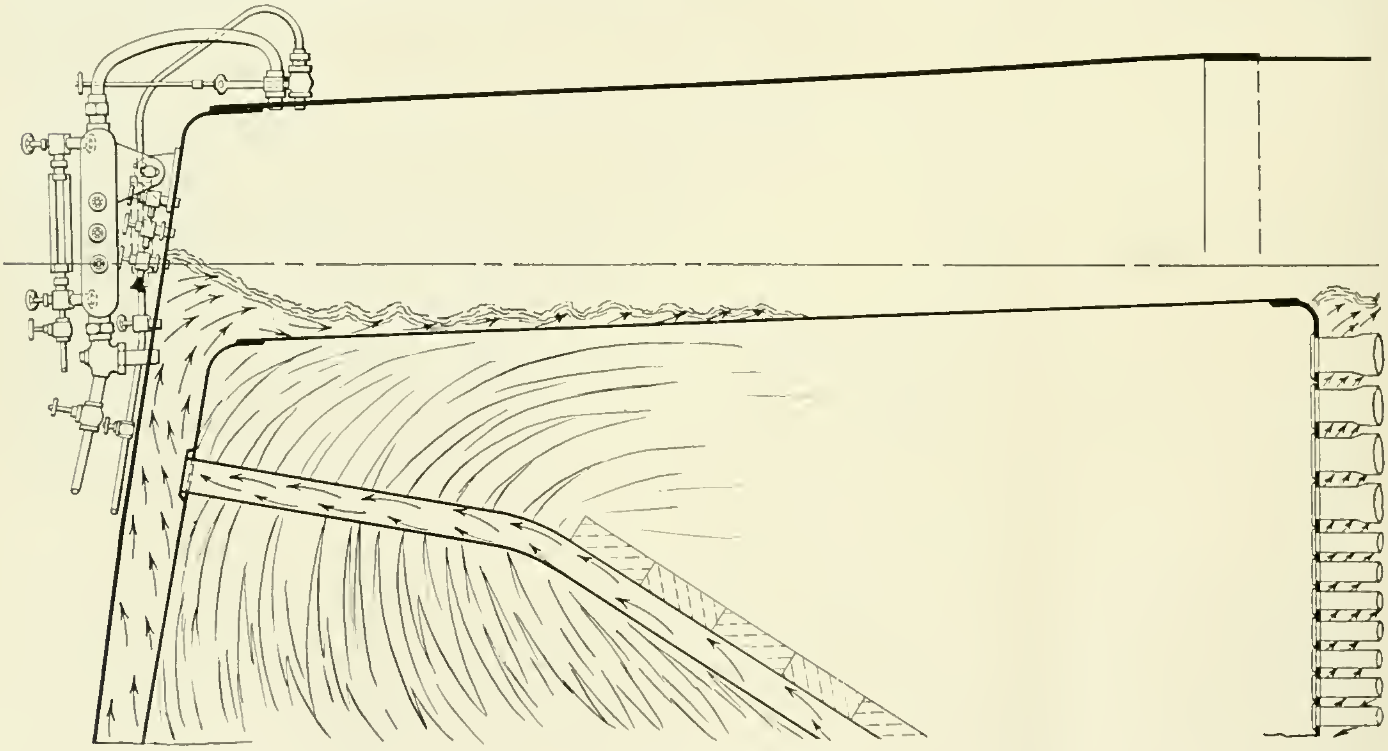


Fig. 6—Dangerous Condition Due to False Registration of Gage Cocks

Fig. 6 illustrates a condition which may exist where the water glass registration is ignored and the gage cocks applied in the boiler are depended upon to register the correct level. Since practically all enginemen have been taught to rely on the gage cocks in preference to the water glass, this is an especially unsafe condition, and is, no doubt, the cause of many damaged crown sheets the reason for which has not been determined.

It is recognized that the volume of water in the boiler increases in proportion to the amount of steam being generated and in the same ratio that the steam bubbles below the surface are formed and expanded, the volume of which depends to a very considerable extent upon the purity of

the water in the boiler and its ability to readily release the steam being generated, consequently increasing the height of water in the same proportion, which height is registered by the water glass.

Since it has been established that gage cocks screwed directly in the boiler do not correctly indicate the general water level, the question arises as to what would be a proper appliance. After careful investigation and tests, it is believed that Fig. 7 illustrates a water column that will afford the safest and most practicable method yet disclosed for accurately indicating the general water level in the boiler under all conditions of service.

Recommended Practice

This arrangement has been recommended by this Bureau and was adopted as recommended practice by the Committee on Standards, of the U. S. Railroad Administration, at its February, 1920, meeting. To this water column three gage cocks and one water glass are shown attached, one water glass applied in the usual manner on the left side of boiler head for the purpose of forming a double check of the height of water over the crown sheet and to broaden the view from different parts of the cab.

Very recent tests indicate that to avoid the possibility of inaccurate readings, due to raising the water in the column when the gage cocks are opened excessively wide, the inside diameter of the column may be made 3½ in. and that of the top connection 2 in. Experiments with column and steam pipe of these dimensions and the ¾-in. opening in the connection to the boiler at the bottom showed that the water in the column glass could not be raised, by opening the gage cock, to exceed ¼ in., regardless of the amount or the length of time the gage cocks were open.

It is recommended that the bottom water glass cock and bottom connection to the water column enter the boiler horizontally, and that the water column and water glasses should stand vertical.

Steam-pipe connections to water columns and water glasses should be made as short as possible, so as to obtain a supply of dry steam at all times, and so arranged as to thoroughly drain and be free from short bends or any possibility of sags or traps. It has been definitely established that where traps or sags that will retain the water of condensation are permitted in the top connection to water glasses or water columns, the reading of the water is materially affected, causing a higher level to be indicated.

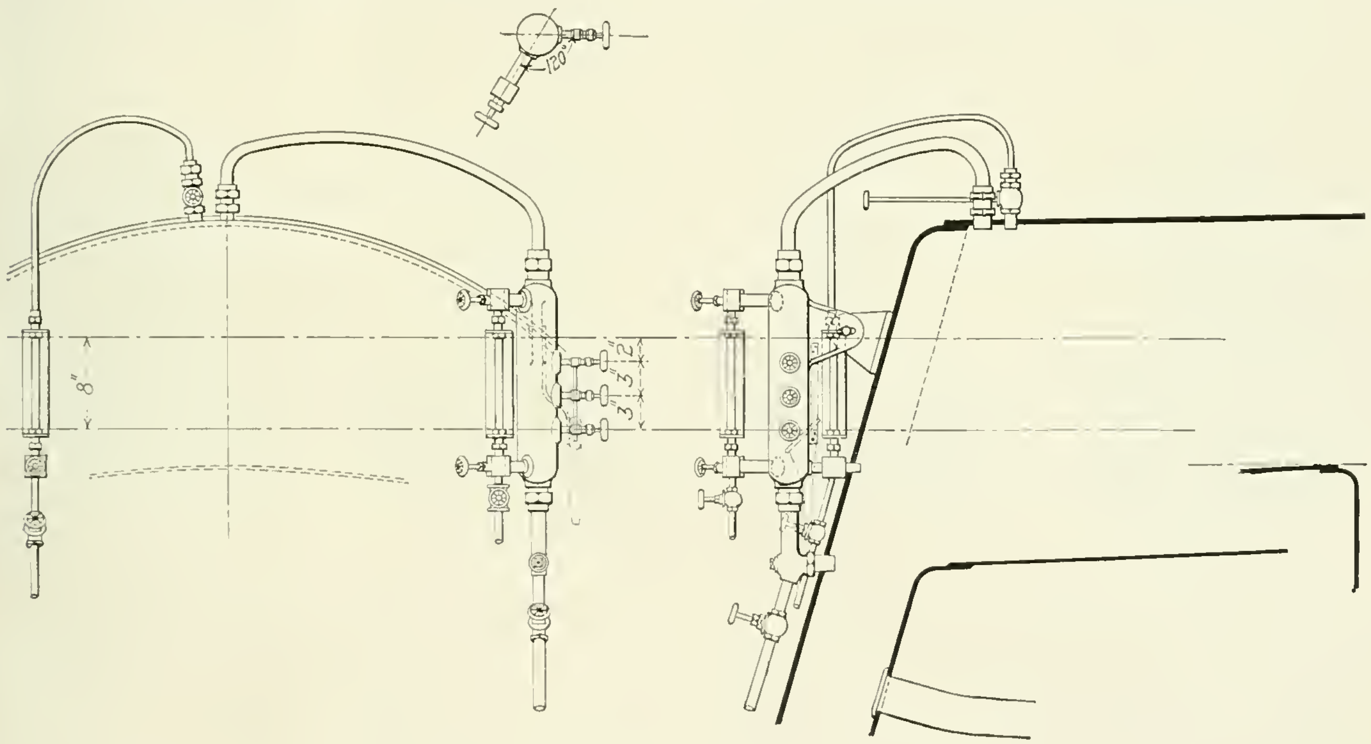


Fig. 7—Recommended Arrangement of Water Indicating Devices

In constructing and applying the water column, the ratio of openings between top and bottom connections, as indicated by Fig. 7, should be retained, and the bottom connection screwed into the boiler far enough to pass all obstructions which may be immediately above them. It was illustrated in the fifth series of tests that when the bottom connection to the column entered the boiler head one inch past flush, and directly under a "T" iron, it caused the water to rise one inch in the column glass, but when extended past the "T" iron, the readings in all glasses corresponded.

The larger connection to the top of the column, and restricted openings in the gage cocks, which should be not more than ¼ in. in diameter, are suggested for the purpose of preventing the water from being raised when the gage cock is opened wide, the object being to compensate for the lowering pressure in the column through the larger top connection, the area of the smallest opening of which should not be less than 1½ in. copper pipe, so preferably larger.

It should be borne in mind that when water glasses are in proper condition to correctly register the water in the boiler, the water is never at rest while under pressure, and that when the water becomes slow or sluggish of movement or in agitation, it indicates an improper condition that should be immediately corrected. Such conditions are usually caused by restriction in the openings in the fixtures, sags or traps in the steam-pipe connection, or the top connection made so as to allow water to enter, and sometimes by bottom connection being improperly located so as to cause steam bubbles to enter.

The water-indicating appliances are among the most important devices on the locomotive, from the viewpoint of safety as well as economy; therefore, every effort should be made to see that they are so constructed, applied and maintained as to properly perform their function under all conditions of service, and so that the enginemen operating the locomotive may have the widest and easiest possible view from their usual and proper positions in the cab.

General Foremen Hold Annual Meeting

Discussion on Methods of Reducing Cost of Equipment Repairs Covered a Wide Range of Subjects

The problem of selecting and training foremen, the handling of labor, the need for adequate machinery and facilities and the scope of the fusion welding processes, in their bearing on reduction in the cost of repairs to cars and locomotives, were the subjects discussed with the keenest interest by the members of the International Railway General Foreman's Association in attendance at the sixteenth annual convention.

The convention was held at the Hotel Sherman, Chicago, September 8 to 10, inclusive, with President W. T. Gale (C. & N. W.) in the chair. Following the customary formal exercises at the opening session, President Gale delivered his address. An abstract of his remarks follows:

President Gale's Address

Much might be said as to ways in which improvements in railway transportation may be made. Government control of the railroads in the United States has now ceased to exist, and it is natural that the railroad companies should desire to return to improved pre-war conditions. There is a demand for earnest effort at increasing the production of essentials and the markets of the world are ready for our country's productions. As foremen in railroad shops we must do our full part in helping to get results. It may be considered a patriotic duty to serve the country in providing efficient and economical transportation for its citizens and products.

In the supervision of employees, foremen can get the best results by dealing kindly but firmly with all men under their charge. Foremen should not be led astray by any impressions of their personal importance, but must rather be filled with the spirit of fairness to all. The interest of their employers can best be served by a proper understanding not only of the materials which they must handle, but also by securing the effective co-operation of all employees under their supervision. The part of the program pertaining to the proper handling of labor should be fully discussed.

Address by Robert Quayle

Robert Quayle, general superintendent of motive power and machinery of the Chicago & North Western, addressed the association, dwelling particularly on the importance of the general foreman's job to the railroad and to the nation. He drew attention to the fact that the ton mile cost of moving freight on American roads is the lowest of any country in the world, Japan ranking next. But while our labor cost averages about $1,600 per man per year, Japan's is only $174, which is some indication of the efficiency of American methods and American railroad men. The part of the general foreman is particularly important in getting results in the mechanical department because of his close contact with all of the details, which in the aggregate must be properly handled to secure the final result desired.

Mr. Quayle said that railroad men are not wholly responsible for the unrest which has been such a potent factor in bringing about the comparatively low productivity of labor at the present time. Railway employees have been expecting increases in wages since before the war and have long been thinking and talking about little else. The recent wage increase, however, has satisfied most of the men. With the dissatisfaction removed the men are now ready to give thought to their work. Mr. Quayle stated that increased production must be obtained through the general foremen, who must exert a steady continuous pressure on the men to get back to pre-war conditions of output. In doing this, however, it must not be forgotten that they are men and they must be dealt with smilingly and with kindly feeling.

STANDARDIZATION OF ENGINE FAILURES AND TERMINAL DELAYS

The committee will not attempt to define what shall or shall not constitute an engine failure, believing that better conclusions can be arrived at after the question has been thoroughly discussed.

"Time cards do not provide for failures, so why have them? While it may be true that there are many failures, let us all try to avoid them if possible, and not make a standard of them, no matter how great or small they may be," says one master mechanic, in writing to the committee.

The following is the line of procedure followed by some roads when an engine failure occurs:

All information relative to the failure is secured from operating officers on division on which failure occurs. Mechanical officers at the division point secure all available information from the engineer, which is also supplemented by a written statement from the engineer.

If, in the opinion of the party receiving the statement from the engineer, the failure was due to improper handling of the locomotive by any member of the crew, the superintendent is requested to have an investigation made by road foreman. If the engineer contends that the failure was due to the engine, or if the work as reported was not properly performed at the terminal from which the engine was dispatched, the party in charge at that terminal is required to make a statement. The engine inspector is required to inspect all engines and check his inspection against the work report of the engineer. He is further required to know that this work was performed in a satisfactory manner before the engine leaves the terminal. The men performing the work are all questioned as to the manner in which the work was performed, and the decision is then made as to whether the work was satisfactorily completed.

In the event of the failure of the parts of a locomotive, the broken parts are collected and delivered to the mechanical engineer for his opinion as to whether the defect was caused by a flaw in the metal, overheating, lack of lubrication, etc. If caused by a flaw, steps are taken at once to secure a statement from the terminals between which the engine has been operating as to what has been observed by inspectors or reported by the engineer. If, in the opinion of the mechanical engineer, the defect was caused by improper construction, he will change the design.

In the event of a failure due to the engine not steaming, the quality of the coal is taken into consideration and the engine's front end, fire box and flues are thoroughly inspected. If flues are stopped up, it is evident that the terminal from which the engine was dispatched is at fault and corrective measures are taken. If failures are due to improper firing or mishandling of the engine, the corrective measures are taken through investigation by the road foreman of engines.

Train dispatchers make four copies of each engine failure report. The superintendent sends one copy to the general superintendent, one to the assistant mechanical superintendent, one to the road foreman of engines, and retains one copy. This report is checked against the engineer's report. If the road foreman of engines considers an engine failure unjustly charged, he writes the superintendent, giving his reasons, and if the superintendent finds that the failure has been charged without cause, he cancels it, using regular report blanks for that purpose and sending copies to the general superintendent, assistant mechanical superintendent and the road foreman of engines.

The following is the personal opinion of a railroad officer of high standing, as to what should be considered an engine failure:

"I do not consider that a break down of less than five minutes should be called a failure. Where there is a delay of five minutes or more and the engineer picks up the time that he has lost in fixing up the engine and arrives at the terminal with no loss of time, this should not be classed as failure. Where an engine has been in excessive duty on the road and the fire gets dirty so that it has to be cleaned in order to complete the trip, I do not consider this is an engine failure, but a transportation failure due to holding engine too long in service.

"Again, a man might frequently stop along the road when he notices a back end of the main rod heating, to ease up the keys, making a delay of probably five minutes, and starting up with his train again and picking up the lost time. This is done to avoid a failure, but in a great many cases it is classed as a failure. At times the train crew sets the brakes from the caboose, pulling a drawbar out of the back of the tank or breaking the drawbar between the engine and tank. This is classed as a failure, but it should not be.

"What should be classed as a failure is an engine failing through leaky tubes when put in excessive service, losing time on the train that she is on, or when any material breaks, being defective in itself or in the workmanship, and causing a delay to exceed five minutes; in fact, any defect that is due to the engine."

W. T. Gale—C. & N. W.
President

J. B. Wright—H. V.
1st Vice President

G. H. Logan—C. & N. W.
2nd Vice President

William Hall—C. & N. W.
Secretary-Treasurer

Meetings should be arranged at frequent intervals when engine and train performance can be discussed freely and wrong practices corrected. The mechanical department should be advised at the earliest possible moment as to what power may be required, thus giving them time to make necessary preparations.

The members of the committee were Wm. Hall (C. & N. W.), chairman; J. R. Harrington (M. K. & T.), M. H. Westbrook (G. T. W.), H. E. Venter (Sou. Pac.), and W. Mulcahy (B. & O.).

Discussion

From the variety of definitions as to what constitutes an engine failure which were given by those who took part in the discussion it seems evident that a direct comparison of engine failure records can scarcely be made on any two railroads in the country. Not only is this true but practices differ in many cases on different divisions of the same system. The desirability of uniformity in the definition of what constitutes an engine failure, particularly on the divisions of the same system, received considerable attention.

Where practices differ, comparisons lead to unjust criticism and have a demoralizing effect on the organization. On the other hand, where the practice is uniform and just comparisons can be made, a spirit of competition to see which division can make the best record may be readily developed. Some of the members felt that efforts should be made to develop a standard for application on all railroads in order that direct comparison might be made between different systems. The effect that different operating conditions should have in establishing the definition was touched on. On a train making local stops, where frequently opportunity is offered to look after the locomotive, a rule that delays be charged whether made up or not is entirely different in its effect than when applied to fast non-stop runs, where it may be necessary to stop the train in order that an adjustment may be made to prevent a complete engine failure later. By comparison, however, injustice is done if such a delay is charged against the engine when the time has been made up before reaching the terminal.

It was also suggested that engine failures should be charged against shop points rather than to divisions. The reason for this is that passenger runs frequently operate over the lines of two or more divisions, the intermediate divisions, however, having no jurisdiction over the power. To charge a failure under these conditions to the division on which it happens to occur leads to unjust comparisons and provides a record which is of no value as a guide to corrective measures.

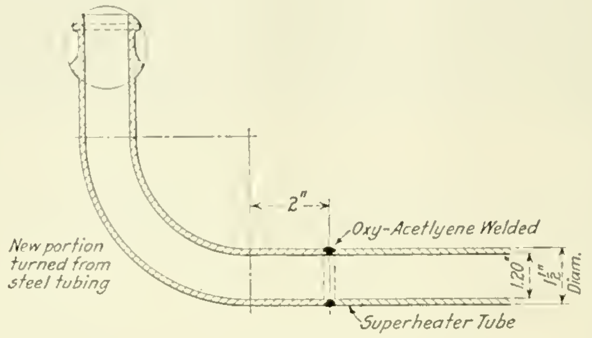
REPAIRING SUPERHEATER UNITS

Superheater units become worn at the front end between the bends and the ball joints. After considerable study and trial, it was found that the best method of repair is first to determine if unit is worn through to cause a failure, or so that they will not last until another shopping. If they pass this inspection, then apply a hydrostatic test of cold water up to 400 lb. While under this pressure the inspector should hammer test parts which show corrosion, especially around the return bend. If the return bends leak, and are worn too badly, they can be repaired by acetylene welding. If worn, there are two ways to repair them economically.

On the old style units the tubes can be cut off with acetylene next to the bend, rethreaded and new bends applied. The new units should be cut off at the return bend with acetylene on an angle of 45 deg., and then by the aid of two air cylinders, with the jaws facing each other, press the ends of the unit, heated to a cherry red, together to form a bend. Then weld the tubes together, using plenty of material to reinforce them on the flat surface and on the end of the bend. After this is done, again apply 400 lb. hydrostatic pressure and hammer test.

To repair the ball joint ends of units, they should be cut off back of the bend, say five to eight inches, with acetylene gas and then belled out to half the thickness of the tube, back 1⅝ in. To make the new ends, the balls are forged on each end of a piece of tubing. This is done in two operations of the forging machine. After being forged the ball joint is turned on a turret lathe and the tube is cut to whatever length is desired, the end being turned to fit the ball end of the tube. These new ends can be made 50 or 100 at a time, machined, ready to apply, and can be distributed to roundhouses or other than main shops which will save considerable time in getting power into service. After the new end is ready, it can be welded by acetylene in a few minutes. The 400 lb. hydrostatic pressure should then be applied to test the unit. After unit is tested, band should be applied and spot welded on each side by the electric or acetylene process to keep the band from slipping. This need not be over ⅜ in. in diameter and ⅛ in. high.

To get the best results in reapplying superheater units to header, the ball joints should be thoroughly cleaned and polished with emery cloth. The joint should then be tried with a standard gage, and if found to be out, should be ground with a mixture of oil and cut steel, using a soft metal grinding form and a small air motor. If joints are badly damaged, they should be trued up with a milling cutter and then ground with oil and cut steel. The joints on the header casting should be thoroughly inspected, and if found to need machining a milling tool opposite to the one used on ball joint should be used, and then ground with oil and cut steel, using a form the same shape as the milling tool. Slots in the superheater header should be carefully inspected to see that they are free from sand or scale and have a square surface, and that the bolt heads are square, so that there will be no chance of the bolts slipping. Threads on the bolts should be carefully examined and if found to be elongated, they should not be used. Steel bolts with strength of not less than 74,000 lb. should be used. After superheaters are applied, they should be pumped to the steam pressure of the boiler and thoroughly inspected to see that all joints are tight.



Method of Renewing Ends for Superheater Units—A. T. & S. F.

Methods Employed on the "Big Four"

Two plants are used for the repairing of superheater units. The plant in the machine shop consists of a reservoir 30 in. by 36 in. which contains two-thirds water and one-third air when charged for service. There is a hydrostatic pump and gage in connection with this reservoir and a sealing cylinder used for sealing the ends of units when testing. A three-way valve having seven ports, is specially designed to complete the entire operation of testing by three movements or positions. These positions of the valve admit air to the unit from the main reservoir to charge and seal the unit; this is the first step taken in this operation. The next is lap position which is also the exhaust position and the other position is known as water position.

The sealing cylinder is specially designed to seal both ends of the unit and form an unrestricted communication between the main reservoir and atmosphere at the lower end of the operating valve. It is provided with a "T" head piston, hollowed out to slip over each unit, coming in contact with the back of the unit head, bringing it against the rubber insertion in the bottom head of the cylinder. The operation is as follows:

Air is admitted to the unit by placing operating valve in "air" position, the air passing from the main air supply through the operating valve, the unit and into the main reservoir. As the air passes through the sealing cylinder the piston is raised by air pressure and seals the unit to the cylinder. Pressure is allowed to accumulate in the main reservoir and unit. The operating valve is then placed in the water position and the exhaust valve under the operating valve opened, allowing air from the unit to escape to the atmosphere. The air pressure in the main reservoir forces water into the unit when the air is released. When water shows at the exhaust port, it is then closed and the hydrostatic pump applies 350 lb. pressure. To release the water from the unit,

the operating valve is placed in the air position, the valve on the main reservoir is opened to allow the pressure to escape and air from the line drives the water back into the main reservoir, leaving the unit free from water. Air from main line is then closed, the exhaust valve opened and unit unsealed.

For repair of units which are bent, at the opposite end of this unit table are two air cylinders placed vertically, one placed over the other, but having separate pistons. The upper cylinder is provided with a continuous piston, traveling through both heads, and is used as a ram to give the bottom cylinder a blow when the air pressure in the lower cylinder is insufficient to straighten the bend in the unit. The lower cylinder also has a double end piston that gives the upper cylinder contact outside of the cylinder. The lower cylinder is used as a squeeze to straighten all four lines of the unit pipes at one time, these lines being separated by sheet metal shims laid horizontally and vertically, adjusted near the point where the piston of the cylinder comes in contact with the unit, properly spacing the four lines of pipe.

If leaks develop under hydrostatic test, these leaks are thoroughly sand blasted, removing all carbon and scale, and the leak is repaired with the acetylene torch.

A portable testing outfit is provided that can be taken to places throughout the shop where units have been removed for testing and grinding only. On either of these plants, the actual time taken for testing a unit is not over two minutes.

In the heavy repair plant, located in the boiler shop, there is a forging machine, with suitable dies for renewing the return bends, and a similar testing plant to the one mentioned above. There are also metal cutting saws for sawing off defective return bends, a sand blasting device for removing all foreign matter from the ends of the units, and a reaming device for reaming the ball ends of the units to the proper radius, preparing them for grinding.

From past experience it has not been profitable to use header bolts with a tensile strength less than 74,000 lb. These bolts are tested for elongation by gaging the thread.

The first superheater equipment was applied in July, 1911, and it is impossible to give the average life of units as the first ones applied are still in service. Units are not scrapped due to loss of weight. The use of micrometer calipers has indicated that the deterioration of the unit is very uniform, there being scarcely any variation between the front end and back end of unit. The most common failures are right at the end of unit where it comes in contact with cinders, and where it is subjected to the greatest temperature. When renewing return bends only enough is cut off to renew the bend. It is not necessary to make any sacrifice in the length of tubing because of the deteriorated condition of that part of the unit.

The report was prepared by the following committee: W. L. Jury (A. T. & S. F.) chairman; J. E. Stone (Sou. Pac.), J. Martin (Big Four), E. P. McDonald (Sou. Pac.) and C. L. Walters (Gt. Nor.).

Discussion

There was considerable discussion of the methods of taking care of header joints. While much of this dealt with the ball and cone joint it developed that a number of roads still use only the ball socket joint in the header. In the discussion on methods of grinding the ball and cone joints, a question was raised as to the necessity of grinding this type of joint since it is evident that the ball has a line joint in the header. With the ball drawn up tight this is bound to crease the joint and a great deal of care in grinding seems unnecessary. It has actually been found unnecessary to grind the joints more than just to clean them up. On the Grand Trunk where this practice has been followed, only two units have been found to leak out of 800 tested. This experience has confirmed the belief that it does not pay to test the units on the erecting floor as the few leaks that develop on the hydrostatic tests can then be touched up without much trouble. Others considered the floor test desirable, however, for the sake of safety and to detect leaks in the back end of the units, which, should they develop under hydrostatic tests, might make necessary the removal of several units in order to get at the defective one.

Attention was also given to the application of the units in the superheater flues, some members considering improper application as the greatest source of leaky joints and, therefore, that attention to the fit of the unit in the tube and to the location of the header, which must be properly lined up with respect to the tube sheet, is of greater importance than attention to the joint itself. Trouble has also been caused by the accumulation of corrosion on the surfaces of the slots in the header, the crushing of which causes the joints to loosen up and leak.

REDUCING THE COST OF REPAIRS TO CARS AND LOCOMOTIVES

The committee dealt with this subject under 17 heads, each of which was outlined briefly with the purpose of stimulating discussion. An abstract of these subdivisions follows:

SUPERVISION

Careful, well trained supervision is essential. Supervisors should have, or acquire, executive ability—the gift of handling men properly; they should be interested in their men and like them. They should be big enough to get their heads and shoulders above the petty envy and jealousy that has a habit of creeping in. Supervisors who are favored with the opportunity to get a schooling in different departments or experience in different shops are indeed fortunate, and can and do return the favor to the company they are working for.

ORGANIZATION OF SUPERVISORS AND SHOP FORCES

In order to have an efficient, energetic and interested shop organization it is necessary to have the co-operation of all members of the staff. To increase this spirit it is advisable to have weekly shop staff meetings at which the welfare of the shop is discussed. At these meetings the shop superintendent or general foreman can get in personal touch with his organization and get a general idea of the condition of each department by the report that each department foreman turns in. This enables him to make any changes which he might deem necessary to further the production in his shop.

At these meetings, too, subjects may be brought up for general discussion, such as general shop conditions or methods to be adopted to shorten the time of machine or erecting floor operations, which tend to decrease the cost of repairs.

ROUNDHOUSE REPAIRS

The first object should be to take care of the small repairs on locomotives, which will take only a short time and require a small amount of material before they cause damage which will require more costly repairs. Roundhouse work properly looked after keeps locomotives out of the back shop a much longer time.

Roundhouse terminals should be provided with inspection pits for inspecting locomotives before passing over the ash pits in order to detect any parts that need repairs and have the information forwarded in advance to the roundhouse so advance preparation can be made for repairs.

BACK SHOP SCHEDULE

There must be a workable shop schedule or plan for getting the work out with the facilities contained in the shop. Since the piecework and bonus systems have been discarded it has been found that production has slowed up, much to the dissatisfaction of all of us. It has, therefore, been necessary

to develop a shop scheduling system to take the place of the other systems.

MACHINERY AND FACILITIES

When it is possible to get new machines or appliances to replace old types they should be obtained immediately, but when this is not possible every loose end should be gathered in and the best made of the situation. There is more money wasted in making repairs to locomotives on account of the use of old and obsolete machinery than there is from any other cause. This is also true on mill work in the car department.

During the past few years locomotives have been growing in size and weight very rapidly; but in many cases the repair shops have not kept pace with them, and the result is high costs of repairs.

There is also another means by which the cost of repairs may be materially reduced and that is by the introduction on the machine floor of jigs, chucks, dies, box tools for brass work, pneumatic clamps, gang tools, milling cutters, templates and expanding mandrels, all of which reduce the cost of machine operations. On the erecting floors, power-driven valve setting rollers, motor-driven valve bushing pulling bars, rings for grinding cylinder faces and cylinder heads with air motor attachment, motor-driven flue cutters and flue rollers and chucks for grinding steam pipe rings and superheater units with motors have been found to greatly reduce the costs of repairs.

ROUTING AND LOCATION OF FACILITIES

All work going through shops should be properly routed, thereby doing away with unnecessary handling, which costs money. For example, all side rod work should be confined to one portion of the shop with rod rack, drill press, power press and lathe in close proximity to one another so that there will be no lost time between the several operations on the different machines. The driving box gang should have the power press, brass crucible for pouring hub liners, planer, boring mill, lathe and shaper within a radius of 10 or 12 ft., as they are in so many shops, so that when a driving box enters that radius it does not get away from it until finished and ready for application.

MATERIAL

Sometimes very little attention is given to the handling of material. A high rated mechanic may sometimes be seen pushing a truck up from the stores department with a load of material on which he is about to perform some kind of work.

This task should be taken care of by a trucker or laborer, thereby saving the difference in the two men's wages while at the same time the mechanic may be used on production.

Every effort should be made to have material placed in well regulated store departments so that when men are sent for certain articles they do not waste time looking for it.

The material required at the shops should be carefully watched by the supervisory forces and ordered in ample time to save delay and avoid the necessity of having to rob material from one engine or car for repair parts to use on another engine or car. Supervisory forces should keep in close touch with the consumption of material and should see that new material is not used unnecessarily, and that all second-hand serviceable material is handled properly to get the greatest amount of service out of it.

A well organized and well equipped central reclaiming plant is a great money saver.

PROPER HANDLING OF LABOR

Every employee should be impressed with the necessity of reducing all unnecessary expenses. A great many men are inclined to be careless about the use of material, especially when somebody else is buying it, and consequently, unless a strict check is kept, much of it is wasted.

To get the men thinking along the right line some roads have arranged to have efficiency meetings in the offices of the master mechanic, between representatives of the shop crafts and the members of the staff about once each month, at which the subjects of shop repairs, use of material and the elimination of waste is discussed. These men take part in the discussion and advance many ideas from the employees' viewpoint which save time and material. Then once in eight or ten weeks a mass meeting is called in the shop 30 minutes before quitting time at which some member of the staff speaks, followed by a representative of the employees, who bring before the men the necessity for conserving material and thereby causing reduction in the cost of repairs.

A spirit of hearty co-operation should be cultivated between the engine crews, road foremen, and shop forces in order to get the help of the engine crews in carefully handling and looking after the engines on the road and making their work reports as explicit as possible.

WORKMANSHIP

Another manner in which the shop organization can keep the cost of repairs down is to insist upon each man doing his work thoroughly, instead of accepting slighted work, which is sometimes done because the engine is wanted in a hurry. This is a very expensive measure because it will not be very long before the job will have to be done over again, at the same expense if not more.

When cars and engines are shopped for general repairs, all parts should be carefully inspected and necessary repairs should be carefully and properly made. They should leave the shop in first-class condition, to render satisfactory service without it being necessary to expend much on them for running repairs. Running repairs are more expensive than back shop repairs because facilities are lacking. Furthermore, the service of the engine is lost while such repairs are being made.

Close care should be given to the proper mounting of car and tender wheels on axles to see that they are properly centered and the wheel gage fits properly at least at three equally distant points on the circumference, and that wheels of same tape sizes are paired. This will tend to reduce flange wear and hot boxes.

WELDING PROCESSES

A great saving in material is effected by the use of the electric welding process. Locomotive parts which formerly had to be scrapped on account of wear, such as guide bars, brake beam ends, brake hanger pins, radius bar ends, fork ends of eccentric rods which have become too wide for the link, driving boxes which have been worn down on the shoe and wedge faces, are now built up by the use of the electric arc and made almost as good as new. The oxy-acetylene torch, in the boiler department especially, is being used quite extensively for the welding in of flues, flue sheets, side sheets and patches, thereby reducing the cost over the old method of applying them with rivets. The use of the cutting torch must not be lost sight of. There is no department which can get more results from it than the locomotive department.

LUBRICATION

The lubrication of the end play on driving, engine truck and trailer boxes, and shoes and wedges with graphite grease prevents the cutting of these faces and increases mileage.

Care should be used to see that the lubricating devices are maintained in good condition and that sufficient amount of lubricating oils are furnished to meet the requirements. Under the present conditions the proper lubrication of cars and engines depends to a large extent on the shop forces.

The supervisory officers should realize this and provide necessary facilities for properly lubricating and looking after the parts in the shops that are not ordinarily given the required attention on the road.

A trained force of men should be maintained to look after the proper packing and lubrication of journal bearings and this work should be followed up by the supervisory forces to insure that it is being handled properly at all times.

DESIGN

Great care should be given to the design of parts to see that they are of sufficient strength and of proper quality to meet the requirements of the service without failing; also to see that the parts on cars, especially, are so designed that they may be easily removed for repairs.

REINFORCING CARS

Draft timbers and gears on wooden cars are the source of high cost of maintenance. The substitution of steel center sills, to which the draft gear is attached, will almost entirely eliminate the maintenance of draft timbers and draft rigging, as it gives a substantial attachment to pull the train and also gives a buffing member which will prevent buckling of cars and, in box cars, the breaking of side plates over side doors.

This feature in present-day heavy trains will more than offset any additional cost of repairs to cars and will have them on the repair track less frequently. Another feature of importance is taking care of the breaking out of ends of box cars.

This can be done by substitution of pressed steel ends, of which there are several kinds on the market, and reinforcing the ends with structural shapes which can be anchored to the side framing, floor framing or roof framing.

INSPECTION

A system of careful inspection should be enforced to detect any defects which may develop that would result in failure or rapid deterioration of parts if not located and given prompt attention.

CLEANLINESS

Engines should be kept clean and of good appearance as both enginemen and shop forces will take more interest in the engines if they are kept clean. This should be followed up by the supervisors and necessary facilities provided to handle the work economically.

Shops and premises should be kept clean and all refuse and material picked up. This raises the morale of the men.

SHORT TRACKS IN CAR REPAIR SHOPS

It is necessary to have short tracks of 10 or 12 cars capacity, and many of them, in order to get bad order cars spotted with regard to the work to be done on them. Short tracks will also aid in more frequent pulling of the bad order tracks and not hold up a large number of cars as is done on long repair tracks. The repair forces can be better supervised with short tracks and material is more easily handled.

CLASSIFICATION OF BAD ORDER CARS

Bad order cars should be classified as to light, heavy, general repairs and steel work or other special work before they are set on the repair track. This method increases the output, allows the work to be specialized and reduces the cost of handling material.

The report was signed by C. F. Baumann (C. & N. W.), chairman, C. W. Adams (M. C.), H. T. Cromwell (B. & O.), and F. L. Wysong (N. & W.).

Discussion

As a means of broadening the experience of supervisors, the discussion indicated that many railroads have adopted the policy of sending groups of their foremen from time to time to visit the principal shops of other railroads. Where this practice has been followed the opinions expressed in every case indicated that the return to the company justified the practice. The value of reading suitable mechanical journals was also mentioned as a means of education which should not be neglected.

The opinion was also expressed that a real foreman requires qualifications which he possesses before he becomes a mechanic. In selecting foremen those men who have demonstrated qualifications of leadership should be tried out as acting foremen in advance of their selection to fill permanent positions.

The discussion indicated that shop scheduling is rapidly coming into general use. The systems described by those taking part in the discussion varied considerably in the details. Most of them, however, depended on periodical conferences of the shop foremen as a means of fixing the outgoing dates which, once established, are followed up consistently by means of schedule boards and daily reports.

The need of close supervision of speeds, feed and depth of cuts on machine tool work was brought out as particularly important at this time in efforts to secure adequate output. Many of the men on machines now seem to have little idea as to the capacity of high speed steel cutters and show little ability to figure out correct speeds and feeds. The tendency, therefore is to take more cuts than are necessary and operate at speeds which waste time. The discussion on workmanship dwelt largely with the importance of eliminating all unnecessary finishing of parts. Since the abolishment of premium and piece-work systems, where these were formerly in force, there has been a tendency for the men to do unnecessary work. In some cases this has been remedied by taking the matter up through the shop committees and impressing on them the need to avoid every possible waste of time.

During the discussion on the welding processes, Professor A. S. Kinsey, Stevens Institute of Technology, addressed the association as a representative of the Welding Conference Committee of the American Welding Society. Professor Kinsey dwelt on the importance of foremen having a more thorough knowledge of the essentials of good fusion welding. He referred to the fact that the Boiler Code Committee of the American Society of Mechanical Engineers will probably give a rating to fusion welds in boiler work and that the rating to be given will depend upon the kind of work that is being turned out. The foreman should know what kind of welds he is getting. Professor Kinsey referred particularly to the National Agreement as a hindrance to the full development of the possibility of fusion welding in railroad shops, since it places the welding jobs open to the senior craftsmen in the various departments, who may not be welders at all.

In discussing the sections of the paper dealing with car maintenance the present practice of maintenance, which goes on patching up the cars while giving no systematic attention to the draft gears, was condemned. It was stated that the same need exists for periodical inspection and repair of draft gears as has led to the present methods of air brake maintenance, and journal boxes. It was pointed out that such a policy adopted with respect to draft gears would soon demonstrate what gears are most economical. The value of the short repair tracks of 10 to 14 cars capacity was endorsed by the car men present.

Other Addresses

T. H. Goodnow, superintendent car department, Chicago & North Western, addressed the association on the problems of the car department. At the outset he called attention to the changed conditions surrounding the relations of foremen to their men, which must now be on the basis of a close

personal contact. These conditions the older men find hard to meet but the younger foremen should have no difficulty in conforming to them. Contrasting conditions in the car department to those in the locomotive department, Mr. Goodnow said that the greater part of the money spent by the car department is for work on outside repair tracks where the need for supervision is greater than in connection with any other railroad activities. Under the piece work system the men constantly kept after the foremen to see that they were furnished material. Since the piece work system has been abolished, however, conditions are reversed; the foremen must now closely watch the men to see that they are not idle because of lack of material at hand.

Mr. Goodnow called attention to the fact that the retirement policies of the railroads had to be abandoned a few years ago, thus continuing in service many old cars of light construction. Cars now cost not less than three times what they did in 1916, but in adopting a re-enforcement program it must not be overlooked that the same conditions prevail with respect to the material required to make the re-enforcements. It must also be taken into consideration that the small capacity car is a low earning unit. Where wood cars of 80,000 lb. capacity can be re-enforced at a cost of about $300 to $500 a good earning unit is provided.

E. W. Pratt, formerly assistant superintendent motive power of the Chicago & North Western also gave a short talk before the convention in which he commented on the fact that most of the subjects for discussion on the program dealt with apparatus or were of a technical nature, while every general foreman in the association probably owed his best job to his ability to handle men. Mr. Pratt suggested that the association might profitably give more attention to subjects dealing with the handling of labor and shop organization.

Election of Officers

The following officers were elected for the ensuing year: President, J. B. Wright (Hocking Valley); vice-president, G. H. Logan (C. & N. W.); second vice-president, H. E. Warner (N. Y. C.); third vice-president, T. J. Mullin (L. E. & W.); fourth vice-president, C. A. Barnes (Belt Railway of Chicago), and secretary-treasurer, William Hall (C. & N. W.). M. H. Westbrooke (Grand Trunk Western) and D. W. Adams (M. C.) were elected to fill vacancies on the executive committee.

CARS MUST BE EQUIPPED WITH SAFETY APPLIANCES

The Interstate Commerce Commission has denied the application of the American Railroad Association on behalf of various railroad companies for a further extension of time within which to make their freight-train cars conform to certain of the standards of equipment prescribed by the commission pursuant to the provisions and requirements of the safety appliance acts.

In accordance with the authority conferred by the provisions of the act the commission had granted successive extensions of the period within which common carriers should comply with the requirements of its order of March 13, 1911, with respect to the equipment of cars actually in service on July 1, 1911, as follows: On March 13, 1911, an extension from July 1, 1911, to July 1, 1916; on November 2, 1915, a further extension to July 1, 1917; on April 12, 1917, a further extension to March 1, 1918; on February 1, 1918, a further extension to September 1, 1919; and on August 29, 1919, a further extension to March, 1, 1920, making one continuous period of eight years and eight months from July 1, 1911, to March 1, 1920. Passenger-train cars and locomotives were equipped in conformity with the standards within the periods prescribed by the first extension order. The second, third, fourth and fifth extension orders pertained to paragraphs b, c, e, and f of the original extension order, paragraphs a, d, and g being so worded as to require no further action.

"The record shows," the commission says in its decision, "that on February 1, 1920, there were 2,319,380 freight cars owned by the carriers represented at the hearing, and that 60,170 of these, or 2.6 per cent of the total owned, were not equipped in conformity with the standards prescribed by the order of March 13, 1911. It is estimated that 3,000 were equipped during the month of February, and that 12,021, or 20 per cent, were special service cars or others cars which do not leave the owning line.

"No reason was given why these 12,021 special service cars have not been equipped in conformity with the law or why they cannot immediately be so equipped. This leaves 45,-149 other cars to be equipped. Sixty per cent of them need minor repairs only, but more or less difficulty is involved in equipping the remaining 18,060. Of these, 9,272 have less than ten inches end-ladder clearance. If a special drawbar is used, the larger percentage of the 9,272 cars can be made to conform to the requirements. The number of bad-order cars on the lines of these carriers is about 138,000, or approximately 6.5 per cent of the total number owned. The percentage of the number of bad-order cars has fluctuated during the last two or three years between a little over 5 and about 10 per cent. Most, if not all, of these non-equipped cars have been through the shops in the last 9 or 10 years. A witness for the carriers stated that he did not know that any car could stay out of the shop that long.

"It can not be maintained that the failure to have these cars equipped in conformity with the standards is due to any unforeseen contingency. The requirement for the standardization of safety-appliance equipment is of long standing, and attention has been directed to this requirement from time to time in previous hearings in this matter as well as in the several extension orders; at the hearing in August, 1919, the situation was discussed and the understanding was had that no further extension would be necessary, asked, or granted. The arguments that shortage of material and absence of the cars from the lines of the owning carriers have delayed the required standardization are not convincing with respect to those cars which require only minor repairs, inasmuch as safety appliances are of standard dimensions and an order issued by the Railroad Administration June 30, 1919, required each carrier to equip all cars on its line not already standardized, regardless of ownership. We have seen that it will be more or less difficult to make 18,060 cars conform to the standards. But if these 18,060 cars are added to the number of bad-order cars, shown by the record to exist on the lines of the carriers, the percentage of bad-order cars will be increased less than 1 per cent, or from 6.5 to 7.3 per cent; and if the entire 60,000 cars not equipped according to standard were added to the number of bad-order cars the percentage of such cars would be increased to 9.2 per cent, a figure less than the maximum, which, according to the record, has existed during the past two or three years.

"It is noted that all of the unstandardized cars referred to herein were in service July 1, 1911, and all of them are consequently nine or more years old. No doubt many of these cars have practically outlived their usefulness and nearly reached the age of retirement. Cars of that age, if they have not heretofore been shopped for extensive repair work, must shortly go through the shops, at which time the safety-appliance equipment can and must be made to conform to the standards.

"Upon consideration of all the facts of record we are of opinion and find that good cause has not been shown for any further extension of the period of compliance and that serious burden or hardship will not be imposed upon the carriers or upon the public by denying the application."

PAINTERS HOLD FIFTIETH ANNIVERSARY CONVENTION

Equipment Painting Division of the American Railroad Association Holds Convention in Boston

THE convention which met in Boston on September 14 was an event of unusual interest and importance to the members of the Equipment Painting Division of Section III, Mechanical, of the American Railroad Association. It is the first convention of this association as a division of the American Railroad, as within the past year the Master Painters became a unit of the American Railroad Association. The Master Car and Locomotive Painters' Association was organized in the city of Boston in 1870 and in the opening exercises of the fiftieth convention, the association was addressed by Mr. Warner Bailey of the Boston & Maine Railroad, who took an active part in the organization of the association and who is now the only living charter member.

Warner Bailey's Address

The following is taken from Mr. Bailey's remarks in regard to the origin of the Association and his splendid conception of its purpose in promoting the welfare of the American railways:

"In the summer of 1870, Hill of the Portland & Kennebec Railroad; Cox of the Eastern Railroad; Scott of the Boston & Lowell; Lunt of the Fitchburg; Platt of the Old Colony; Ford of the Boston & Worcester; and Bailey of Boston & Maine, met together by previous arrangement and talked over the question of forming this association. I was chosen for the task of addressing a circular letter to be sent to foremen painters and the only guide I had was 'Poor's Railroad Manual.' In most cases only the president's and superintendent's names were there given and the call was sent to them with a request that it be handed to their foreman painter. On November 6, 1870, when the meeting was called, sixteen members responded. Hill of Augusta was made chairman of the meeting. After appointing a committee to draw up a constitution and by-laws and selecting a few subjects to be discussed at our next meeting we adjourned to meet in New York City the following year.

Photo by Kimball Studio, Concord, N. H.

Warner Bailey

"For many years we, as an association, struggled along without much increase in numbers, and little encouragement from any source, until we added to our numbers by taking in foremen locomotive painters and foremen of car manufacturing shops, both steam and street car. Also Canada was admitted with this addition, and today we number about three hundred members.

"We have always kept in mind the object of this association, as stated in the circular letter issued for the first meeting; and that was to perfect ourselves in our trade that we might be of more benefit to corporations employing us. I think we have always kept this object in view; and that

our yearly reports prove this.

"Among the notable members that have belonged to the association, who in times past have added greatly to our information, is James A. Gohen. Quest, with his technical papers, and Miller, with his practical papers, have added greatly to our knowledge, while Copp, Butts and a score of others of equal note have helped to make this association what it is today.

"What is the prospect for our association? I can safely say that this association will keep on indefinitely in its career of usefulness if the same principles actuate you as moved the founders of it; and this was to perfect themselves in their trade. If you know it all, then there is nothing for you to do but quit these assemblies, unless you come together wholly for a good time; and in this you might well consider whether or not it might better be spent in other ways and places. We do not know it all yet. New kinds of equipment and new ways of doing things are constantly developing and you will always want to keep these meetings going to discuss them.

"A year ago you dropped your name and entered the American Railroad Association as a unit in that great and useful organization. Let us hope this will widen the scope of your usefulness, as doubtless it will."

Chairman Gibbons' Address

In his opening address, Chairman J. W. Gibbons of the Atchison, Topeka & Santa Fe spoke of painting as one of the oldest arts, deriving its origin and receiving impetus in the desire of the human race to beautify its surroundings. Thus, in the beginning ornamentation was the dominant feature that impelled or inspired the craftsman. As the art progressed and developed, the thought of the painter was to preserve his work for the pleasure and inspiration of future generations. In order to accomplish this purpose, he studied the vehicle that carried and held his pigments together and assisted him to make the correct blend and shade of color, as well as protect the finished product from the ravages of time and weather. As the use of wood became more general, the quality of oils and gums became more important and were not only used to preserve the wood but to beautify it by imparting to it variegated colors and a lasting polish.

To solve these problems which have developed with the advent of the railways, Mr. Gibbons said that the painters realized the necessity of getting together for the discussion of application and formulating combinations of vehicles and pigments best adapted to perform the service required. With this object in view, The International Association of Master Car and Locomotive Painters was organized fifty years ago. When it is realized that at that time it required from six to ten weeks to paint a railway coach with no better or durable surface than we now secure in fifteen to eighteen days, it proves that these painters must have been inspired with the same independence of thought and action that inspired the patriots of American colonies to discard the traditions and prejudices of the past and build for the present and the future.

Chairman Gibbons stated that the paint manufacturers have derived more benefit from the work of this association than the railroads, because the manufacturer's welfare and success in business depended upon his keeping in touch with the most advanced thought of the day pertaining to paint, while on the other hand railroad mechanical officials have frequently and openly declared that the paint questions was the least of their troubles and are wasting thousands of dollars every day by the purchase and application of poor paint.

In concluding his address, Mr. Gibbons said that no section or department is undergoing such rapid changes as that of paint, its manufacture and application. The high price of raw materials, heretofore recognized as essentials, has offered a great temptation to substitute inferior materials into the finished product and it devolves upon the association to point out how far we can go with safety and economy along this line.

Business of the Association

The chairman announced that during the year the association had received a number of new members and that at the present time the membership of the Equipment Painting Division of Section III-Mechanical, of the American Railroad Association was in excess of 500.

J. W. Gibbons
Chairman

E. L. Younger
Vice Chairman

V. R. Hawthorne
Secretary

The committee on direction, as its name indicates, directs the affairs of the association between conventions and was requested by the A. R. A. to elect a committee of three to act with a similar committee from the purchasing, stores and chemical sections to prepare specifications and arrange tests for paints and varnishes. Mr. John Gearheart, Mr. John D. Wright and the chairman were elected to this committee. The committee at its last meeting passed a resolution requesting the committee on nomination to select the 1st and 2nd vice-chairman with the idea of their promotion in rotation and that the 2nd vice-chairman be selected from the board of directors and the selection of new members of the board from members who on the committees and on the floor have demonstrated their ability in this work. The division was requested to appoint a committee to co-operate with the Committee on Car Repair Shop Layouts of Section III-Mechanical, and the Committee on Shops and Terminals of Section II-Engineering, for the purpose of arriving at standards which would assist in the design for future paint shop construction. The new Committee on Direction was instructed to select a committee for this purpose.

The chairman expressed the thanks of the association for the frequent advice and courtesies extended by the officers of

the American Railroad Association and particularly for the very able assistance rendered by Mr. Hawthorne, secretary of mechanical section and this division.

The convention adjourned after electing the following officers for the ensuing year: B. L. Younger, Missouri Pacific, chairman; J. G. Keil, N. Y. C., first vice-chairman, and J. R. Ayers, Canadian Pacific, second vice-chairman.

THE ECONOMICAL PAINTING OF PASSENGER TRAIN STEEL CARS

BY G. H. HAMMOND
M. St. P. and S. S. M.

On a sand blasted car there is generally applied a coat of steel primer which is followed by several coats of steel surfacer. After the surfacer has been made smooth, two coats of body color are applied followed by the necessary lettering, and the whole protected by two or three coats of body varnish.

The steel primer comes to us all ready to apply, and is highly recommended for the first coat on steel. The material is a thin varnish-like substance, colored or clear according to its source of manufacture, and is *not* recommended as a protection to steel when used alone. It must itself be protected by other paints.

What is surfacer, and why is it applied to steel cars? It is simply another form of putty, and the only reason why it is used is to obtain a smoother and more level surface. For this reason its composition must of necessity be inelastic and chalky. If exposed to the weather alone it would fail completely.

After the surfacing coats have been worked into a satisfactory condition, the color coats are applied to it. These two color coats are made up of body color ground in Japan and thinned to a working consistency by the mixing in of turpentine or turpentine substitute. The body color coatings if exposed alone to the weather would soon disappear and be of no value in protecting steel from rust.

So far in the process of painting a steel car three classes of materials have been used—the priming coat, the surfacing coats and the color coats, and none of these coatings, alone or together, would protect steel from rusting more than a short time. What then is the protection from rust? Varnish must be the answer; two or three coats are applied on top of all the previous unstable coatings. It must not only ward off the weather, but must also hold the previous coatings to their place.

This method of painting steel cars is simply applying to steel practices and material found adaptable to wood, and the results are not satisfactory. Cracking of the varnish, peeling, and rust spots appear all too soon. These coatings which are put on so carefully and part of which are rubbed off with equal care, and which we know to be so poorly adapted to the protection of steel, must be mainly responsible for the unsatisfactory results. This being the case why not eliminate such material entirely from a place on the bodies of our steel passenger cars, and not only save the cost of such material but the big item of labor required to apply it, and use only such material as we know to be elastic and durable?

One coat of body color and three coats of varnish is all that a steel passenger car body really needs and it will remain bright and lustrous much longer than those cars loaded with many coats. The body color should be furnished in paste form, ground in equal parts of raw linseed oil and gold size japan. To prepare it for one coat work on sand blasted steel or repainted cars, reduce it with raw linseed oil, and nothing else, to a consistency that will cover with one coat, apply with a bristle brush and smooth with a hair brush. The next day all necessary lettering is done. All places lettered with leaf should be well pounced with whiting before sizing to prevent leaf from sticking to body color, and be washed off when the lettering is dry. The following day the first coat of varnish is applied, followed by two more, forty-eight hours apart, until three coats are applied, at which time the car body is finished.

You will notice that no other work is done except these four coats and the necessary lettering, and you will perhaps wonder how a steel car finished in this manner would look. It will have all the brilliance of color and all the varnish luster that could be desired, and as for the smoothness of finish, unless a very close inspection is made, no difference in finish would be noticed. Cars constructed of plates riveted together will not show a level surface; regardless of what the painter may attempt to do to make it so, each plate will show bulges or depressions which are impossible to eliminate and barring deep pits in the surface of the steel, any surfacer or putty applied is so much material and labor wasted. Steel plates containing pits should never be accepted if placed in a position to show on the outside of a steel passenger car. Cars constructed of thin steel in imitation of wood sheathing are perfectly smooth and level before being sent to the paint shop, therefore any surfacer or putty applied would be superfluous.

When it is necessary to repaint, the old varnish is sand papered, a coat of oil color is applied, followed by three coats of varnish. After several shoppings such cars become just as smooth at close inspection as a surfaced car.

Discussion

J. D. Wright: The Association cannot go on record as recommending one coat of body color and three coats of the best outside wearing body varnish as a standard method of finishing the exterior of passenger cars. While the method may be feasible with an oxide of iron color, it may not be feasible with a color which is composed of ochre or chrome yellow and carbon black and a very small percentage of red, which are the pigments used in the manufacture of what is known as standard Pullman body color.

J. B. Ayers (C. P.): Dr. Johnson, engineer of tests for the Pullman Company, told me up until six or eight years ago considerable cold rolled steel was used in the construction of passenger equipment. That steel is very similar to the present steel extensively used by the automobile body builders. That steel is smooth and does not contain flash scale or pits. I believe cars on the Soo Line are fortunate enough to have steel of that character.

Mr. Butts: As an experiment I took two Pullman coaches, and treated them exactly the same, the same day, with the same kind of material. One was put on the run north to Winnipeg and back, and kept on that run for twelve months. The other car, painted exactly the same, went on the Portland, Oregon, run and was kept there for twelve months. At the end of the twelve months the one on the Winnipeg run was in fine condition, needed nothing but touching up the varnish. On the one on the Portland division, the varnish was so badly decomposed that it had allowed the surfacer to be attacked by the alkali, and we had to burn the car off. You cannot adopt a standard for all parts of the United States and make it a success for painting passenger equipment.

REPORT OF COMMITTEE ON MAINTENANCE AND CARE OF PAINT AND VARNISH AT TERMINALS

The committee would first urge that the attention of passenger equipment at terminals should be under the supervision of a man who is familiar with the nature of paint and varnish, so that the cleaning done at terminals would not be done with materials and in such a manner as to injure or hasten the termination of durability to varnish and paint; that cars after coming from the shop freshly painted should not be cleaned with the use of a solution of any kind until such time as the condition of the car makes this absolutely

necessary. In maintaining and caring for the paint and varnish of such cars at terminals, a dry wiping with waste after each trip is all that is necessary. When the condition of the car becomes such that it is necessary to use a cleaning solution, an oil emulsion that is made neutral and has a tendency to feed the varnish should be used, care to be taken that it is wiped absolutely dry before car is again put into service, as car is bound to gather a certain amount of dust and dirt immediately after this treatment. After car has been cleaned in this manner, it can again be taken care of for some time by simply dry wiping after each trip.

The committee is unanimous in recommending that soap and water should never be used in the open air at terminals for cleaning the exterior of passenger cars, unless immediately rinsed off with clean water and dried thoroughly with a chamois, as the sun will dry soap and water on the surface of car very rapidly, thus injuring the varnish. A practical demonstration of this may be made by washing your automobile with soap and water and rinsing with clear water without drying thoroughly with a chamois.

Painted floors of cars should not be mopped with a strong solution of any kind, but when mopping is done use only a weak solution of oil soap with a proper disinfectant, which will not injure floors. If this practice is followed, floors will not require repainting as often as otherwise would be the case.

It is very important that roofs of cars be inspected frequently at terminals, and if necessary repainted without waiting until the car is shopped for general repairs or repainting. If this practice is followed, it will tend to preserve the roofs so that when car is finally shopped for general repairs and repainting the roofs will be in good condition and will not need extensive repairs.

The interior of passenger cars should have the varnish or enamel wiped occasionally with cloth dampened with neutral interior renovating oil, which will brighten and renew the varnish or enamel greatly and improve the appearance of the interior and will also assist in preserving the varnish or enamel.

The committee does not approve of the use of washing or scrubbing machines on the tanks or cabs of locomotives, but sees no objection to their use in cleaning the frame, wheels, etc. It has been the experience of the members of the committee that the use of these machine on varnished surfaces is very injurious to the varnish.

Cleaning Enamel and Varnish Surfaces

In order to obtain the best service from cars painted with enamel without varnish, the car should be primed and surfaced in the usual way and given two coats of oil varnish enamel, which dies very slowly. It has been the experience of the committee that the clear varnish enamel does not give the same surface as the oil varnish enamel. The use of oil varnish enamel, which dries very slowly, necessitates allowing more time between applying coats, thus delaying the return of car to revenue service.

Gold leaf lettering cannot be used on such enamel, as the enamel being of a finishing coating the leaf adheres around the edges, therefore the lettering must be of an imitation of gold, that is a gold color paint. A car finished in this manner does not have the same high lustre nor give the same satisfaction in appearance as the car painted in the usual manner and given the usual coatings of clear finishing varnish, although, considering the first cost, the car can be painted with enamel for a few dollars less than with varnish. In cleaning the cars at terminals, however, the car with the varnished surface can be cleaned more easily and present a much better appearance and with less cost, because on the varnish finished surface the dirt has not formed a part of the painted surface. In the case of the enamel finished car, however, it is much more difficult to clean and does not present as near a satisfactory appearance after cleaning, as the dirt and dust adhere to the painted surface.

Another very important point and worthy of consideration is the fact that the enamel surface will not bear as frequent cleaning as the surface finished with varnish. When an enameled car is scrubbed, it is generally found necessary to enamel again with two coats and reletter car, while the varnished car can be scrubbed and either touched up and varnished or cut in and varnished, according to color of body, with less cost than enameling and relettering.

It was the conclusion of your committee that, giving due consideration to appearance and cost, it is preferable for the purpose of cleaning to have passenger equipment finished with varnish.

The report is signed by: A. H. Phillips, N. Y. O. & W.; J. W. Houser, C. V.; Jas Gratton, B. R. & P.; E. A. Witte, T. R. R. Asso., St. Louis; J. W. Quarles, C. & O.

REPORT OF COMMITTEE ON STANDARDS

The committee recommends the universal adoption of the standard of the former Master Car Builders' Association for uniform stenciling and lettering of freight equipment and suggests that every effort should be made to put this standard of lettering in practice. The universal use of this standard would eliminate the making of innumerable stencils and a great amount of hand work, and should bring about considerable reduction in expense.

The report states that the general adoption of this standard method of lettering freight car equipment would solve one of the perplexing and annoying problems which confront the railroad men entrusted with taking of car records. It is believed that the standard method of numbering and stenciling recommended by the former Master Car Builders' Association, and now a standard of the Mechanical Section of the American Railroad Association, would eliminate such errors and save much annoyance.

Exhibit "A" shows the cost of making stencils required for lettering freight car equipment of the different railroad lines. These costs are based on old figures and at rates of wages which have increased considerably since that time, so, in all probability, they would be from 30 to 40 per cent higher at the present time.

Exhibit A.—Cost of making special stencils for marking freight cars.

Pittsburgh & Lake Erie, 4 in. Roman	$5.00
L. E. & W. R. R., 5 in. Roman	2.00
L. S. & M. S. R. R., 5 in. Roman	8.00
New York, Chicago & St. Louis, 5 in. Roman	8.00
Pennsylvania R. R., 5 in. Roman	4.00
Buffalo, Rochester & Pittsburgh, 5 in. Roman	7.00
Lehigh Valley R. R., 5 in. Roman	6.00
Erie, 6 in. Extended R. R. Block	1.50
Michigan Central, 6 in. Roman	3.00
Chicago, Milwaukee & St. Paul, 6 in. Roman	8.00
C. C. C. & St. L., 6 in. Roman	9.00
C. I. & L., Roman	8.50
K. C. F. S. & M., 5 in. Block	1.00
Wabash R. R., 3½ in. Full Block	1.50
Northern Pacific, 6 in Roman	6.00
T., St. L. & W., 6 in. Roman	2.00
Missouri Pacific, 5 in. Round Block	3.00
Kanawha & Michigan, 6 in. Roman	4.00
St. Louis, Iron Mountain & Southern, 5 in. Roman	8.00
C., St. P., M. & O., 5½ in. Roman	9.00
Chicago & Alton, Extended Roman	4.00
Rock Island, 8 in. Roman	3.00
Grand Trunk, 8 in. Egyptian	3.00
Central Vermont, 6 in. Roman	4.00
Bangor & Aroostook, 8 in. Roman	4.00
Atlantic Coast Line, 4 in. Roman	3.00
Boston & Maine, 5 in. Roman	3.00
Norfolk & Western, Roman	6.00
Southern, 12 in. Roman	3.00
Mobile & Ohio, 6 in. Roman	3.00
Baltimore & Ohio, 5 in. Roman	3.00
Central R. R. of New Jersey, 5 in. Roman	5.00
Pere Marquette, 4 in. Antique Roman	6.00

On repair yard tracks it is estimated that 60 per cent of all repairing is to foreign car equipment, most of which requires the replacement of more or less stenciling in order to maintain the identity of the cars. This requires the repairing line to carry in stock stencils of nearly every type and size of

letter and number. Some of these stencils are used frequently and others not so often. Nevertheless, it is necessary to keep this stock of stencils, for most repairs are of the hurry-up kind which excludes off-hand lettering.

The committee recommends that trade marks or badges should be part of the expense for each individual car owner to assume if they wish same replaced on their equipment. The stencils for these trade marks are very expensive, as the attached exhibit "B" will show, and the committee would recommend their discontinuance, as the only reason for their use seems to be as a means of advertisement. Most trade marks require backgrounds other than the standard colors used for painting equipment, and thus require an extra application of paint. This necessarily delays the completion of the car and at the same time adds to the cost of stenciling.

Exhibit B.—Cost of Making Stencils for a Few of the Most Complicated Badges or Trade Marks.

Morris & Company, Old Style	$20.00
Nelson Morris & Co., Shaded	10.00
Louisville & Arkansas	4.00
Old Dutch Cleanser	6.00
The Niagara Falls Route	3.00
Clover Leaf, Plain	1 50
Arkansas River	3.00
Queen & Crescent Route, Egyptian	3.00
Ann Arbor	2.00
Philadelphia & Reading, Lower-Case Roman	2.00
Frisco System, 7 in. Egyptian	2.00
Lehigh Valley, Flag	2.00
Pennsylvania Lines, Arrow and Anchor	1.00
New York, New Haven & Hartford	12.00
Iowa Central	2 00
Wisconsin Central	2.00
Mobile & Ohio	1.00
Burlington Route	2.00
New York Central Lines	4.00

As the committee believes that economy is the watchword of the railroads today, the elimination of these shields and trade marks is one practical way to reduce expense.

Recommended Practice for Painting Freight Car Equipment

As the protection is an absolute necessity, the committee recommends that the new steel car should have a coat of red lead applied to all lapped parts before assembling. Upon completion of construction the exterior should be thoroughly cleaned and prepared by sand blasting. A priming or first coat of paint should immediately be applied both inside and outside. This should be a linseed oil mixture requiring twenty-four hours to dry.

The carbon blacks are the best wearing and the most appropriate coating for this class of equipment. After this, and perhaps but little less in wearing quality, are the oxide of iron pigments. The preparation of this coat, as to pigment and vehicle, should be such as to insure an ideal binding and elastic film. A second coat with about one-third more oil should be applied. Great care should be taken to see that every part of the car is covered. Both coats can be effectively applied by spraying. For patch work or repainting the same method should be applied as in new work, that is, all scale and rust removed and two coats of paint applied.

The recommendation of the committee is to use one coat of primer made from red lead and oil, followed by a coat of carbon black in oil. This has not been generally carried out because of the first coat of raw material, red lead being high in price. As an alternative, the committee would suggest the use of carbon black in oil or graphite, or preferably iron oxide in oil.

Carbon paints are not safe to use as contact coats on metal as they are good conductors of electricity and act as rust stimulants. However, they make good top coats. Graphite paints are not good inhibitors of rust because of the ease with which they conduct electricity. It has no action on oils except to retard drying. It is a greasy pigment and slides under the brush and the particles tend to segregate and should be mixed with a heavier pigment to give it tooth. Asphaltum and coal tar black has practically no value as a protective coating. It generally contains no oil at all, has very little toughness, and its acidity tends to promote action of rust.

No part of railroad equipment is more essential than the air brakes, and one of the most frequent causes for defective brakes noted is leaky trainlines caused from rusted pipes becoming weakened and breaking at joints. Air brake lines have been frequently observed in so rusted a condition that whole sections of the piping had to be removed on account of rust having caused the sections to become porous. For this reason it would seem most essential that they should be protected with paint and continually watched. A well painted air brake line will render inspection of this part of the equipment easy and will also lead to detection of flaws and breaks which can be reported to the proper officer.

Recommended Facilities for Freight Car Painting

The most convenient place to paint freight car equipment, weather conditions being favorable, is on the outside of shops located as conveniently as is possible to the place where the repairing is done. The longitudinal tracks are best adapted for this work and should be properly equipped with air lines, with plenty of space between tracks. A stationary scaffold of simple construction is very convenient and a great time saver. Care should be taken that such tracks used for painting should be kept exclusively for painting purposes, for the reason that the tracks must be kept clean of all rubbish or obstruction in order to facilitate the painting work and thus insure quick return of cars to revenue earning service.

The best system of painting freight equipment and in standardizing results obtained by such painting is to do the work in properly constructed shops. This will allow a uniform amount of work under varying weather conditions. It will also permit planning the work and directing it properly, rather than having cars located all over the yards and men working without adequate protection or supervision. Where spraying machines are used in closed shops, provision should be made for sufficient ventilation. There are times when freight cars can be satisfactorily and efficiently painted on the outside of shops, but during most of the year work in the North can only be properly done within four walls and under a roof. For this reason a shop for painting freight cars is both economical and efficient.

Recommended Frequency for Painting

It is becoming most essential because of lower production and higher cost of labor, material and new equipment, that greater care be taken in the inspection and painting of steel equipment on railroads. Attention should be given to inspection of freight cars at yards, and a repair or patching crew should be kept at principal junction points equipped with material necessary to fight rust. Steel freight cars should be brought into shop for repainting and repairing every three or four years.

Opinions vary very much with regard to the time a car should be brought in for general overhauling and repainting. If the initial preparation and painting has been properly done and cars not subjected to unfair usage, such as the hammering of sides for the purpose of dislodging, or the loading of hot slag or billets in cars, there is no reason why coal carrying cars should not give three years' service before reshopping. The use of such cars for storage of coal during winter months is very injurious as the sulphur drippings from coal will very soon destroy the paint film and cause corrosion to the parts attacked. All steel box cars, if properly painted at the beginning, should give a longer term of service. However, the under portions such as channel irons, underframes, etc., must be continually watched and kept painted.

In view of the above, it is the opinion of the committee that the standard practice on railroads should include thorough overhauling of all steel freight cars at least once every five years and the painting of underframes at every opportunity offered.

The report is signed by: S. E. Breese, N. Y. C. (chair-

man); G. J. Lehman, C. & E. I.; F. E. Long, C. B. & Q.; W. A. Buchanon, D., L. & W.; C. A. Cook, Pennsylvania.

Resolution Adopted

Whereas a large proportion of freight equipment cars in service bear markings not conforming to the American Railroad Association recommended standards as shown on drawings 26, 26a and 27, thereby making necessary the use of an endless variety of sizes and types of letters and figures. And whereas, the condition greatly increases the cost of repairs to foreign line cars, due to the necessity of applying markings by hand, or the making of numerous stencils for temporary use; and whereas, the condition is frequently the cause of wrong numbers being recorded by transportation department employees, causing confusion and needless correspondence; be it therefore resolved, that this division recommends any action necessary to urge all railroads to follow a uniform practice and use markings as recommended by the American Railroad Association, also that a rule be adopted making it permissible to use such markings, disregarding the manner in which the cars were previously stenciled, and making all marks of an advertising character billable against the owners.

INDIVIDUAL PAPER ON ECONOMY TO BE EFFECTED BY PROPER PAINTING

BY B. E. MILLER
Delaware, Lackawanna & Western

In order that economy in the maintenance of equipment by painting may be effected in the fullest measure, cars and locomotives should be shopped and given the needed attention whenever their condition demands it. Again the management has to be reckoned with. Can locomotives in serviceable condition be spared for painting? No. Neither can cars, especially freight equipment, when there is an abundance of business and a shortage of rolling stock. The consequence is frequently disastrous. Witness the present condition of the average freight car throughout the country today. The cars of all rairoads having been pooled during recent government control, little attention was given to the matter of painting. The result was soon apparent. Steel coal-carrying cars, many of which were in none too good condition when the government took hold, began to look disgraceful; rust, that arch enemy of steel, was making rapid progress. Some of the cars are in such bad shape as to make their cleaning up and conditioning for repainting practically impossible. In many cases, the last coat of paint, probably a poor article when applied, has disintegrated and washed off, leaving no protection to the surface and exposing double lines of lettering frequently, which, to say the least, is very annoying and proves the wisdom of applying a paint possessing durability, though it means perhaps a little additional time for drying or an extra coat of paint to insure wearing results. The present "run down at the heel" appearance of equipment might of course have been avoided had it not been for the war, scarcity of help, the peculiar conditions due to government control, etc. Had it been possible to give the cars *proper* painting when their condition made it advisable, many dollars might have been saved to the railroads, so far as the painting itself is concerned and deterioration avoided. Especially does this apply to steel equipment and steel portions of wooden cars.

True economy in the painting of railway equipment means to do the work promptly, once it has been determined that painting is necessary. This ought to be made plain even if there is no hope of influencing those who decide as to when cars can be spared from service for painting and when financial conditions will warrant the expenditures necessary to do the work.

Use only good serviceable materials. As a rule, it doesn't pay to bother with anything else. The present high cost of labor and the difficulty of securing it, demand that money shall not be thrown away, partly at least, in the direction of applying paints and other materials which lack efficiency and durability. It requires no mathematician to figure out that, as a rule, the higher priced material proves itself to be the cheapest in the end. This has been said so often and evidently with so little effect, that we almost hesitate to repeat it.

Purchasing agents, unless strong pressure is brought to bear, are inclined to invite ruinous competition when placing orders for supplies. In the matter of paints, as with other materials, they are apt to purchase solely on price, unless they can be successfully convinced that, in some cases at least, it is rank folly to do so. Happy indeed ought the painter to be whose complaints, when made to the proper official, receive the attention they merit and eventually reach the person responsible for the placing of orders. His duty and aim is to save money. If he can be thoroughly convinced that paying more for material means in the end true economy, he will often he persuaded to buy the higher priced goods.

Discussion

J. W. Gibbons (A., T. & S. F.): Five years ago, in a shop within my knowledge twelve per cent of all the steel cabs coming through required new roofs, because of improper painting and care. After the officials' attention had been called to that condition, and a standard practice adopted, not only of painting, but of keeping them clean, each year from that time until this day there has been a gradual lessening of expense, until last year there was not a single full roof put on any of the locomotive cabs coming through that shop. Five years ago there were twenty-five sides put on steel cabs; last year there were three.

I have noticed our steel passenger cars, the deck side particularly, panel after panel corroded through. If these had been properly painted when they were constructed or when they were in the shop at the last period, all of that labor and material would have been saved to the railroad company Our superiors oftentimes do not have the slightest idea of what could be saved by proper painting.

Very few of us can say that we are using the best material, and that has been particularly true in the last two or three years. Price has been the first consideration, but should be the last consideration. If the painter knows his business, his word should be accepted.

W. A. Buchanon (D., L. & W.): I have frequently had occasion to look over steel equipment, and just recently looked over some new steel equipment just from the factory that had been painted, and well painted as far as material went, over mill scale. It is the height of folly to attempt to paint over mill scale and expect it to stand. It should first be removed or you will throw away good material in painting steel cars.

W. O. Quest (P. & L. E.): The road I represent was one of the first to get steel car equipment. I remember reading an article by a mechanical engineer to the effect that a steel car would last thirty years on two paintings, the original and one painting afterwards. At that time I presume he failed to take into account how a steel car was to be abused around these mills, with hot slag and hot billets, and the other deleterious things that came afterwards. I recall reading another article in which another mechanical engineer claimed that in ten years they would be falling down on the lines, which also was a mistake.

Paint is necessary to keep steel cars to long life, the best paint you can buy and with the very best sort of application. The original painting must be considered. The original painting of steel car equipment should not be forced to the extent of two coats a day in order to get the equipment out. You have a great many cars, and it is difficult

to figure when you will get those cars in the shops. You say a car must come in every five years, but you don't know whether it will or not. But the thing to do is to paint every steel car.

REPORT OF COMMITTEE ON TESTS

The committee in its report has assigned each subject under consideration to an individual member of the committee. These individual papers have the approval of the entire committee and are presented herewith.

WHAT IS THE SO-CALLED FIXED PAINT OIL?

BY W. O. QUEST
Chairman, Pittsburgh & Lake Erie

Does the term fixed paint oil exclusively apply to the chemistry of paint making? Is this oil fixing confined to the proper fixing of commercial linseed oil, or does it mean that any kind or compounds of oils containing a partial or whole percentage of body weight lin-oxygen can be made through further admixture into heavy bodied substitutes that will answer the same purpose as the pure treated or properly fixed linseed oil. This question has caused much thought and study, owing to the fact that immense quantities of oils other than linseed are used today in paint making and consumption.

The writer is now offering something new along the line of oil fixing, which is an attempt at oxidizing non-oxidizing oils, with their after removal in film form for your tolerant inspection. These oils range from a locomotive cylinder oil down to the oil of goose grease. The idea of such a test was to ascertain if there was an available trick material that would oxidize or dry fix grease oils into films that could be removed—removed regardless of the apparent impracticability of the scheme. They may not mean anything, unless such tests would prove that there are oxidizing materials neutrally fit and strong enough to set up or turn a non-oxidizing oil into something like a fixed paint oil to a bodied film that can be removed, viewed and handled.

For your further information, will state that the same method and amounts of a specially made japan were used on all of the non-oxidizing oil films taken off, also that the drying time periods and results were fairly uniform. A fixed paint oil other than linseed should be so labeled, called by its right name; if not, the use of such spurious materials should not be encouraged in the railway paint shop.

COMPARATIVE VALUES OF TUNG NUT (CHINA WOOD) OIL $2.00 VARNISHES vs. THE OLD STANDARD FOSSIL GUM, SUCH AS ZANZIBAR MANILLA OR KAURI

BY THEO. HIMBURG
D. & R. G.

The committee calls attention to the fact that many American varnish manufacturing concerns claim they have discovered a dependable substitute for the old time honored, high priced fossil gum, railway body varnish which has always rated in the railway paint shop as the only acceptable grade of protective wearing varnish.

The committee has done some experimenting with china wood oil for its own benefit. Some linseed oil was boiled at 550 deg. F. for several hours, and it boiled slowly and uniformly. When china wood oil was heated to this same temperature it changed in a very short time from a liquid to a semi-solid state, in which form it was disintegrated and sticky. It seems that when wood oil is thus heated and solidified it is useless, because it is insoluble in turpentine, naphtha, benzol, alcohol or any commercial thinner.

There is one thing which can control it, and that is rosin. If rosin be added just at the point when the oil is passing from the liquid to this useless state, it brings it back to the liquid form. Furthermore, this action can be repeated several times and finally, when the mass is reduced with turpentine or other solvent, it soaks it up like a sponge. This phenomena is called false body by the varnish makers.

With exactly the same quantity of gum and oil they can, for example, make two varnishes of the same viscosity, but with one containing twice as much thinner as the other. It is obvious, though, one will have only half the true oil content of the other and proportionately less durability. To all physical appearances, such as body and dry, they are identical.

It is universally recognized that china wood oil fills a distinct need. It has unequalled waterproofing properties, but lacks the refinement and working of linseed oil. A proper combination of the two should give the ideal varnish.

A straight china wood oil varnish when allowed to stand open will first form jelly-like "gobs" and quickly skin over. Also, when it dries and is rubbed the film does not cut down cleanly like linseed oil, but it will be noticed particularly under a magnifying glass that it has a tendency to "rough."

Petroleum distillate has more cutting power than turpentine, that is to say, the addition of identical amounts of petroleum distillate and turpentine to the same quantity of a varnish will give a thinner body in the case of the one reduced with petroleum distillate. As there is no turpentine in these two-dollar varnishes, we therefore spread less of a wearing film on our work. Finally, the big saving must come in the gum, and it is apparent that they are rosin, or part rosin, varnishes and false bodied according to price, for the varnish maker is going to make his profit. We have had too much experience to compare high acid-bearing rosin with fossil gums.

To our minds it is a destructive chemical action which must certainly reflect itself in the durability of the varnish. We are decidedly not standpatters. The old varnishes cannot be compared with a blended varnish combining the best elements of both linseed oil and china wood oil, but we do not want any truck varnishes in our hands. We like to smell some turpentine in our varnish, and when we put on a finishing coat we want approximately 100 per cent pure oil content in the dried out film and not a manipulated one which gives us half the oil and half the durability which we have a right to expect.

STEEL PASSENGER CAR ROOF PAINT

BY F. B. DAVENPORT
Pennsylvania System

The paint maintenance of the steam railway passenger car roof has always been a serious problem from the pioneer day of the good old-fashioned iron-made, tin-roofed car down to the present time modern roof, which may be weather protected with canvas, burlap, wood fibre, paper, or the modern steel plate, which must be service protected with a good paint, usually either of the good old stand-by iron oxide or carbon black pigment made up roof coatings.

There should be no trouble with the modern steel car roof, if originally sand blasted or otherwise freed of dirt, grease, flash, scale or loose corrosive matter and followed up with especially designed paint, which if of good elastic material quality will give a maximum of service results, as practically proven up to date. Regardless of pigment used, a tough, hard elastic varnish-like priming coat should be applied on the roof of the new steel passenger car. Repeated hard, long oil in suitable heavy oil-bearing pigments of fixed, never-changing standards should also be used for all subsequent roof coatings while the car is in service. There possibly may be better roof paints than those made of long oil and the usual calcined oxides of lead, iron and carbon blacks. The committee has attempted to test out several of the so-claimed to be fixed combinations of essential oils, gas coal, asphaltum, pine and kettle bottom tars, fire-flame proofed with asbestos or magnesia fibre. The slower oxidizing oils and pine tar are

undoubtedly most successfully used as oxidizing retarders.

The test committee had the opportunity of investigating the practical service time applied, also the shop test results of several of the new idea tar combined paint or roof cements. The tests proved that regardless of the promoters' claim for the best of these roof cements, the metal surface of the new or old roof had to be thoroughly cleaned and freed of dirt, grease, rust and scale, also that brushed on coats gave better protective wearing results than the heavy knifed-on single coat, also that the mixed-in asbestos or magnesia fibre made a better fire resisting material where reduced almost to a dust. The hard set up and the time continued elastic wearing qualities of these tarry combinations are going to prove worth investigating.

Arranged hot coating tests, also shop practice results show that the use of the best or worst surfacing system priming materials on the new steel passenger car roof is a mistake, owing to the fact that, as a rule, such quick-drying make-up primers will not for any length of time withstand the intense heat of the sun's rays as attracted by the solid metal roof surface. An all-steel passenger car roof is no place for a volatile paint of any kind. It has also been practically demonstrated that it is a mistake to sand the entire metal roof of a steel car, as the applied sand is also a strong sun attractive that helps bleach out the much needed elastic life of the oil in the roof paint. As stated above, all new coatings or recoatings will give better and longer service results where the same formulas of mixed paint stock are used on all protective coatings applied.

THE CHEAP DENATURED ALCOHOLS VERSUS THE GRAIN-PROOF ALCOHOL IN RAILWAY CAR PAINT SHOPS

BY J. N. VOERGE
G. C. & S. F.

Will the future practical tests show that the cheaper vegetable commercial alcohols, lawfully denatured with some solvent mineral spirit, make a dependable substitute shellac varnish for the railway car paint shop? Owing to prohibition, the ban has been put on all things purely alcoholic. The privilege of shop handling grain-proof alcohol, owing to the strict government regulation is a thing of the past.

A good substitute shellac is the cry of the hour. As an offered remedy material, we have many laboratory products of the volatile solvent kind, which include the denatured alcohols, also several of the deodorized acid ether derivatives, including the coal tar by-product ethers; the latter in many cases were found to be more neutral and better solvent gum cutting mixtures than many of the alcohols. The cheaper mineral spirit, vegetable denatured alcohols, in our judgment, made a fairly satisfactory shellac varnish under test. The material dries a little slowly, also was found to be very quick in turning dark where too long exposed to the air in coating application, but we found it would leave a tough elastic shellac film, a tougher film we think than all grain-proof alcohol shellac will leave.

The 10 per cent alcohol denatured cheap vegetable alcohol would make a shellac varnish equal to any requirement of the car paint shop, but its practical use for the purpose is out of the question, which leaves the mineral spirit denatured alcohol shellac the last choice lawfully in the field.

The committee received a gum substitute shellac made up in a fairly deodorized ether that made a strong bid for shop recognition, owing to the fact that the specialty would set up quick and sandpaper finish without tearing equal to any of pure raw shellac cut gum under test. The white and light orange shellac films exhibited represent the mineral spirit denatured alcohol cut shellac still further retarded to show that a quick spirit varnish can be made elastic enough to be taken off in film form.

ARE THERE SUITABLE SUBSTITUTES FOR TURPENTINE? IF SO, FOR WHAT PURPOSE MAY THEY BE USED?

BY C. F. MAYER
C., St. P., M. & O.

Oil or spirits of turpentine, commonly known as turpentine, is obtained chiefly from the long-leaf pine, though a portion is also obtained from Cuban and a little from Loblolly pine. The Forest Service has found that Loblolly, short-leaf and Virginia pines yield equal in quantity to the long-leaf yellow pines, and as the former occur in large quantities in the South their utilization adds largely to the turpentine resources of the country. The turpentine producing area in this country is practically confined to the coastal plains region of the Southern states. In the earlier days the industry was best developed in North Carolina, but, owing to the destructive methods of turpentine orcharding in conjunction with lumbering, fires, etc., the industry has gradually worked southward and westward until at present Florida produces the most turpentine, followed by Georgia, Alabama, Mississippi, Louisiana, North Carolina, South Carolina and Texas.

It is the trade practice to grade turpentine according to its color, and the various grades are known as "Water white," "Standard," "off one shade," "off two shades" and "off three shades." The latter is not merchantable. Under the trade regulations the deduction in price "off one shade" is 2½ cents per gallon, and "off two shades" 4 cents per gallon. Of late years, however, it has become customary to mix the colored turpentine with water-white or standard turpentine, adding a small quantity to each barrel. By this practice the producer receives more for his colored turpentine than he otherwise would under the trade regulations, and but one grade of turpentine is generally known to the buyer. There are, however, properties and methods of production decidedly different in the quality of various lots of turpentine. Recognizing this fact, many users of large quantities buy on definite and rather strict specifications, and it would probably be of advantage to the trade if several grades for turpentine were more generally recognized. The turpentine on the American market is quite frequently adulterated with cheaper and inferior oils, those most commonly employed being the petroleum oils having specific gravities corresponding closely to that of turpentine. Other adulterants are certain coal-tar oils, rosin spirits and wood turpentine which closely resemble turpentine in specific gravity and distilling temperature. Though it is known that spirits of turpentine is very frequently adulterated, to our knowledge no systematic investigation of the subject in this country is on record. The committee is of the opinion that this so claimed indispensable material is not always made on an honest, assured material standard, and is to some extent products of the spirits distilled from the strong poisonous, possibly tannic-charged, hemlock pine, saturated tarry pine tree stumps, pine shavings and sawdust. Odors have been invented in the laboratories so as to make some of the clever products so closely resembling that they can be sold as pure turpentine.

Owing to the extensive use of the various substitutes for turpentine, there should be no scarcity of turpentine. We have not been able to find statistics which show that the source from which turpentine is derived is becoming exhausted, although some people are of the opinion that turpentine will eventually disappear from the paint trade. Chemistry of the highest order is undoubtedly used in the production and commercialization of many of the new by-products, and the paint consumer can rest assured that there is no turpentine source thrown away today.

The committee finds that the only material value of turpentine is its solvent or evaporative powers where used in the painting process. Inasmuch as the turpentine evaporates

after the application of the paint, it ceases after the evaporation to have a material effect upon the character or durability of the paint. When mixed in paint, turpentine may be said to perform one particular service. It enables the painter to apply paint to surfaces with an amount of fixed oil or binding material present that would be too small to give fluid paint and produce the desired flat effect unless turpentine or some suitable substitute were present.

The test committee has made a number of substitute turpentine tests, which were mostly of the fixed or safe gravity mineral spirits order, also of one or two of the smelly coal-tar solvent kind, also some acid ethers. In testing the substitute turpentines, we found that their solvent power varied very much when coming in contact with the several makes of grinding japans we especially selected for test purposes, owing to the idea that the quality of the japan was more to blame for the average substitute turpentine failures than the substitute used. The japans used were a first-class standard make, graded as best shellac, good gum, and soft rosin made-up japans, the quality of each being first class. Of the nine substitute turpentines under test, four samples had solvent cutting power enough to cut the soft rosin japan with but little gum souring in the closed up bottles. The remaining five soured almost uniformly bad. Two out of the nine substitute samples soured badly in contact with the Kauri gum japan, the solvent power of the remaining seven samples only slightly clouded, which proved that the neutral mixing qualities of the Kauri japan were superior to the soft rosin japan. The hard shellac gum made japan neutrally mixed with the entire nine substitutes in a flawless manner, conclusively showing that if the grinding japan is made receptive the best of the mineral substitute turpentines could be exclusively used for all paint and japan color reducing out purposes in the railway car paint shop. If, when adopting the substitute turpentine, you find that it will do everything but clean out a lousy varnish brush, clean out your brush with varnish remover, which is much better and cheaper for the purpose as the cared for remover may be repeatedly used for brush cleaning.

The committee has also tried out five substitutes for turpentine against turpentine in a practical way for all purposes where turpentine is being used, such as fillers, stains, color varnish, flat leads, flat colors for exterior of passenger cars, etc. We find that these substitutes evaporate slower than turpentine, and colors mixed with them do not flat out as quickly as colors mixed with turpentine. They all, however, flat out equally as flat as turpentine, and we find that they are not so slow that it in any way delays the work. We have experienced no trouble in applying varnish over surfaces painted with color mixed with these substitutes. Varnish did not crawl or pit, and flowed out and dried equally as well as varnish that was applied over colors mixed with turpentine. We have been able to carry out the work with these substitutes successfully and apparently equally as well as with turpentine. What the final results from the use of these substitutes will be we are not prepared to say.

From our observations and tests, and from what we have been able to learn regarding the various substitute turpentines that are being placed on the market at the present time, most of them are petroleum products, and it is claimed by those who place them on the market that they are especially refined products absolutely free from grease, sulphur or other chemicals and are of the proper physical property necessary to take the place of turpentine. At one end of the series of petroleum we have gasoline, which evaporates very rapidly and is of no use practically in the preparation of paints. At the other end of the series we have products approaching kerosene, which evaporate so slowly that they also are useless in paints. Between these two extremes, however, it is claimed that there are a series of light petroleum oils which, if properly refined, are very useful in the preparation of paints. Many of these light petroleum oils, it is claimed, contain a small proportion of non-volatile oil which, if large enough in quantity, will have an injurious effect upon the paint made from them and the painting results obtained. In recent years, however, there has been a marked improvement in the manufacture of light petroleum oil, and it is claimed that some of them are exceedingly useful and produce with fair satisfaction the results which turpentine produces. From our investigation and tests of the various substitutes, we feel that there is a possibility of their being of value, either in place of turpentine or as an addition to turpentine, which at present prices would be a large saving in railway equipment painting. Before, however, the extensive use of substitutes is recommended we feel that it is a problem for the master painter to solve by practical test and results obtained therefrom.

The active paint craftsman should have no regrets at the passing of pure turpentine, as he, as well as the chemist or pharmacist, knows that the volatile gases thrown off from the purest turpentine are deadly poisonous to the human system; in fact, there is nothing more harmful to the confined indoor painter than breathing the pungent fumes thrown off from turpentine spirits. No doubt there is a wide difference of opinion on this subject among the master painters. Most of us have made tests of the various substitutes for turpentine, which have proved to be a complete failure. From our tests and experiments we are of the opinion that a vast improvement has been made in the refining of the products from which substitutes for turpentine are obtained, and the products of five, ten or fifteen years ago cannot be compared with those that are being placed on the market at the present time.

Discussion

W. O. Quest (P. & L. E.). You will find by looking over the samples that there are but two that show up well with the rosin japan, without getting gelatinous or souring. That was a revelation to me. That proved the contention that it might be the form of japan that we used. When we used the Kauri gum we had a little better average. Out of the nine, four of them behaved fairly well. The rest of them soured a little. When you come to the shellac, they are all clear. There was no gelatinous or souring effect. I am not making an issue out of this, but I have always been under the impression that when railroad companies buy what they call Q. D. colors, they should be ground in the best japan procurable. There should never be any cheap japan used; that is, for outside or engine work.

There is a difference in the solubility of the pure turpentine and substitutes, as a rule. In my experimenting I did not find one single substitute that did not have as much dissolving power as pure turpentine.

Another point that might be valuable to present was the coal tar preparations. Coal tar ethers have more solubility than anything we handled, and they could be used in quick drying colors. They get away as quickly as turpentine, and one or two a little quicker than any substitute we have.

It is of course not our object to try to manipulate any one kind of material. In regard to this japan, rosin japan is all right in connection with oil paint. There are few of us who haven't had trouble with putting a coat of paint on today that will lift up tomorrow when you put on another coat. It is nothing else in the world but the soluble japan that causes that. Take a japan that is made with some of your harder gum, and you can put two coats on in a day, and you would not dare to do that with gum of such solubility as rosin japan might develop into. I would not go on record as condemning rosin japan or Kauri japan, but we ought to have something that will dry hard for our body coats on coaches and locomotives.

J. R. Ayers (C. P. R. R.): I have had considerable ex-

perience for a good many years with various substitute turpentines. While I experienced trouble with certain brands, others I have used with entire success with japan colors. At the present time we are using fully 99 per cent of substitute turpentine with absolutely perfect results; we have not had any injurious effects. As far as thinning of oil paints is concerned, with the present rate we are using now, we are getting results equally as good as with pure turpentine. I know of one instance in which we had trouble with material that contained zinc, the substitute was a little higher in sulphur content than permissible to use, and I believe a great deal of the trouble the painters have experienced with substitute turpentine can be traced to the sulphur content of the substitute or the grinding of the japan, the colors which they tried to mix the substitute with.

Mr. D. C. Sherwood (N. Y. C.): We have had several experiences with substitute turpentine, also in the drying of our body colors and it would not dry as quickly as the pure turpentine and after being varnished it would be a different shade, but I feel we can use substitute turpentine, that is, if it is a very good grade. We have had some good and some bad. We can use it in surfacer. We have experienced no trouble at all in thinning down our surfacer, but I don't think we can get along without pure turpentine.

REPORT OF COMMITTEE ON SHOP CONSTRUCTION AND EQUIPMENT

The question of fully equipping a point shop to obtain efficiency, to yield a large output of locomotives, freight and passenger cars, and to insure better means of safety, is a broad matter to which attention of officials should be called. Many of the paint shops today, if equipped so as to represent one of a modernized type, would minimize the time now required for painting a car and would boost the output of finished cars or locomotives, thus making the shop function to its utmost capacity.

One essential part of the equipment that is not available in many shops is stationary scaffolding. Temporary scaffolds may prove to be satisfactory on small jobs or work that requires but little time, but speaking of a shop that has many cars to be turned out in a day, the stationary scaffolds are a necessity. They save many hours a day that could be used by the men in painting cars or locomotives. To move planks and trestles of the temporary type of scaffolds, three or four men have to stop other work. More accidents occur among the workmen who handle such apparatus.

The report is signed by: J. F. Gearhart (chairman), Pennsylvania; G. E. Grammer, Pullman Co.; A. J. Bishop, N. P.

REPORT OF COMMITTEE ON CLASSIFICATION OF PAINTING REPAIRS AND SHOPPING AND EQUIPMENT

The committee reported that the shopping of cars should be determined by the length of time in service or the general condition of car. As a general proposition the class of painting repairs should be determined by the paint foreman on arrival of cars at shops, and should receive treatment according to class of painting repairs, as follows:

SCHEDULE OF CLASS "A" REPAIRS
Steel Dining or Private Cars
Outside Operations—Body.

1st day—Sandblast and prime with standard primer.
2nd day—No operation (dry).
3rd day—1st coat of surfacer.
4th day—Putty and knife in pitted and uneven surface.
5th day—2nd coat of surfacer.
6th day—3rd coat of surfacer.
7th day—4th coat of surfacer (if necessary).
8th day—Rub with rubbing brick and water. (Guide coat previous to rubbing if desired).
9th day—Sand and touch up rubbed through spots, if any, with standard primer.
10th day—1st coat color.
11th day—2nd coat color.
12th day—Letter and 1st coat of finishing varnish.
13th day—No operation.
14th day—2nd coat of finishing varnish (flowed on as full as possible).

Roof and Deck.

1st day—Sandblast and prime with an approved pigment and oil primer. Allow at least 48 hours to dry.
Paint roof with two coats of standard roof paint.
Paint deck with two coats of body color in oil or standard roof paint, according to Railway Company's standard practice.

Trucks, Platforms and Underneath Work.

Trucks, platforms and battery boxes, paint with one coat of an approved oil paint, followed by one coat of an approved truck enamel.
Underneath work, paint with two coats of an approved oil paint.

Inside Operations.

When necessary to remove paint and varnish:
1st day—Remove paint and varnish with an approved varnish remover.
2nd day—Prime with an approved primer.
3rd day—No operation (dry).
*4th day—1st coat of surfacer of an approved kind and shade.
5th day—Putty and knife in pitted and uneven surface.
6th day—2nd coat of surfacer, same as before.
7th day—3rd coat of surfacer, same as before.
8th day—Rub with rubbing brick and water.
9th day—Sand and touch up rubbed through spots, if any, with primer.
10th day—1st coat of ground color.
11th day—2nd coat of ground color, if surfacer is of desired color this operation may be omitted.
12th day—Grain.
13th day—Varnish.
14th day—Stripe, number and necessary notices applied.
15th day—Varnish.
16th day—No operation (dry).
17th day } Rub to produce standard finish as required by Railway
18th day } Company.

*Surfacer should be of a shade close to the graining ground color.

Head Lining Operations.

1st day—Prime.
2nd day—No operation (dry).
†3rd day—1st coat of surfacer.
4th day—Sand and 1st coat of enamel.
5th day—No operation (dry).
6th day—Finishing coat of enamel.
7th day—Stripe and ornament.

†If a stippled effect is desired, surface coat should be stippled and a preparatory coat used instead of the 1st coat of enamel, which also should be stippled.

Eighteen days consumed to finish this class of car, followed by two days for trimming, and O. K. on the 21st day.

SCHEDULE OF CLASS "A" REPAIRS
Steel Coach

The outside operations on a steel coach to be the same as those used on dining and private cars.

Inside Operation.

1st day—Remove paint and varnish with an approved varnish remover.
2nd day—Prime with an approved primer.
3rd day—No operation (dry).
4th day—1st coat surfacer of an approved kind and shade.
**5th day—Putty and knife all pitted and uneven surface.
6th day—Sand and 1st coat of enamel.
7th day—No operation (dry).
8th day—2nd coat of enamel.
9th day—Stripe and ornament, apply necessary notices and number of car with transfers.

**If Railway Company's standard requires graining, operations from ereon will be the same as with the dining car previously scheduled.

Head lining, roof and deck, trucks, platforms and underneath to receive same operations as those scheduled for dining and private cars.

Fourteen days consumed to finish this class of car, followed by two days for trimming, and O. K. on the 17th day.

SCHEDULE OF CLASS "A" REPAIRS
Steel Mail, Mail and Baggage and Baggage Cars
Outside Operations—Body.

1st day—Sandblast and prime with an approved primer.
2nd day—No operation (dry).
3rd day—1st coat of surfacer.
*4th day—Sand and 1st coat of body color in oil, or an oil enamel.
5th day—No operation (dry).
6th day—Finishing coat of body color in oil, or an oil enamel.
7th day—Letter.

*If Railway Company's standard will not permit of above appearance the schedule as applied to coaches, etc., can be applied here.

Roof and deck to receive same operation as those used on dining and private cars.

Trucks and underneath to receive same treatment as dining and private cars.

Inside Operations.

1st day—Prime with an approved primer.
2nd day—Putty.
3rd day—1st coat of an approved coating, standard shade.
4th day—No operation (dry).
5th day—Finishing coat of oil color or enamel, standard shade.
6th day—Paint steam coils and guards, and do necessary stenciling.

Note: The finishing coat for mail, and mail end of mail ang baggage cars, to be applied as per specifications issued by the United States Railway Mail Service. Seven days consumed to finish these classes of cars, followed by one day for trimming, and O. K. on the 9th day.

SCHEDULE OF CLASS "A" REPAIRS
Wood Dining or Private Cars

The outside operations on this class of cars to be the same as used on the steel type, with the exception that wood cars shall have the paint and varnish burned off.

If the Railway Company's standard does not require the block rubbed surface. Surfacer of the sanding variety should be substituted on the wood sheathed car, and sandpaper used to reduce surfacer instead of block rubbing with stone and water.

Roof and Deck.

Where canvas roof is applied:

Roof board joints to be properly leveled, etc., and primed with an approved pigment primer; the following day canvas to be applied in accordance with Railway Company's standard practice. Care should be taken to see that the back canvas is properly coated with an approved canvas roof protective coating and stretched and fastened in place while the coating is still wet, the outside of canvas should then be protected with three coats of an approved canvas roof protective coating.

Deck to receive three coats of body color in oil, or standard roof paint, according to Railway Company's standard practice.

When roof composition is applied that needs no painting, the deck to receive same treatment as stated above.

Trucks, platforms and underneath work to receive same treatment as applied to steel dining and private cars.

Inside Operation.

When necessary to remove paint and varnish with varnish remover:
1st day—Remove paint and varnish with an approved varnish remover.
2nd day—Sand and clean up by carpenters properly.
3rd day—Fill.
4th day—1st varnish.
5th day—Stripe, number and necessary notices applied.
6th day—2nd varnish.
7th day—No operation (dry).
8th day—3rd varnish.
9th day—No operation (dry).
10th and 11th days—Rub to produce standard finish as required by Railway Company.

Head lining to receive same treatment as applied to steel dining and private cars.

Fourteen days consumed to finish this class of car, followed by two days for trimming, and O. K. on the 17th day.

SCHEDULE OF CLASS "A" REPAIRS

Wood Coach

First-class coaches receive the same treatment accorded dining and private cars, with the exception of rubbing the inside with rotten stone.

SCHEDULE OF CLASS "A" REPAIRS

Wood Mail, Mail and Baggage and Baggage Cars

Outside Operations.

When necessary to burn off old paint, which should be very rare if body color in oil is used, the following operations to be applied:
1st day—Burn off paint.
2nd day—Sand and clean up by carpenters.
3rd day—Prime with an oil pigment primer.
4th day—Putty.
5th day—Coat with an elastic coating of desired shade.
6th day—No operation (dry).
7th day—Coat of body color in oil or oil enamel.
8th day—Letter.

Roof and deck to receive the same treatment as accorded wood coach.

Trucks, platforms and underneath work to receive same treatment as accorded wood coach.

Inside to receive same treatment as accorded steel type of this class of cars.

SCHEDULE OF CLASS "B" REPAIRS

Steel Dining or Private Cars

Outside Operations.

Car to be washed; after necessary repairs are made the following treatment to be accorded:
1st day—Prime new or bruised parts.
2nd day—Touch up parts with surfacer.
***3rd day—Putty and knife in parts.
4th day—Sand and 1st color.
5th day—2nd color.
6th day—Letter.
7th day—1st varnish.
8th day—No operation (dry).
9th day—Finishing coat of varnish flowed on as full as possible.

***If knifed in parts are large they should be rubbed out with block pumice stone and water; this will necessarily require an extra day in schedule.

Inside Operations.

1st day—Prime new or bruised parts.
2nd day—Touch up parts with surfacer of a shade close to the ground color.
3rd day—Putty and knife in parts; same should be of a shade close to ground color.
4th day—Sand and ground color parts.
5th day—Grain parts.
6th day—Varnish newly grained parts.
7th day—Varnish all over.
8th day—No operation (dry).
9th day—Rub to produce standard finish, as required by Railway Company.

Roof to receive two coats of standard roof paint.

Deck to receive two coats of body color in oil or standard roof paint, according to Railway Company's standard practice.

Trucks, platforms and battery boxes to receive one coat of enamel.

Underneath work to receive one coat of an approved oil paint.

Nine days consumed to finish this class of car, followed by two days for trimming, and O. K. on the 12th day.

SCHEDULE OF CLASS "B" REPAIRS

Steel Coach

The outside operations on a steel coach to be the same as those used on dining and private cars.

Inside Operations.

1st day—Prime new or bruised parts.
2nd day—Touch up parts with surfacer.
3rd day—Putty and knife in parts.
*4th day—Sand and touch up new or bruised parts with enamel.
5th day—No operation (dry).
6th day—Enamel body and head lining.
7th day—Stripe head lining, apply number and necessary notices with transfers.

*If interior is to be grained all bruised parts will have to be given proper ground coat, grained, etc.

Roof to receive two coats of standard roof paint.

Deck to receive two coats of body color in oil, or standard roof paint, according to Railway Company's standard practice.

Trucks, battery boxes and underneath work, one coat of an approved oil paint.

Platforms, one coat of enamel.

Nine days consumed to finish this class of car, followed by two days for trimming, and O. K. on the 12th day.

SCHEDULE OF CLASS "B" REPAIR.

Steel or Wood Mail, Mail and Baggage, and Baggage Cars

After car is washed and necessary repairs made, the following treatment to be accorded:
1st day—New or bruised parts touched up with body color in oil, or an approved primer.
2nd day—Putty.
*3rd day—Sand and 1st coat of body color in oil, or an oil enamel.
4th day—No operation (dry).
5th day—Coat of body color in oil or an oil enamel.
6th day—Letter.

*If Railway Company's standard will not permit of above appearance the schedule as applies to coaches, etc., can be applied here.

Roof to receive two coats of standard roof paint.

Deck to receive two coats of body color in oil or standard roof paint, according to Railway Company's standard practice.

Trucks, battery boxes and underneath work, one coat of an approved oil paint.

Inside Operations.

1st day—New or bruised parts touched up with color or an approved primer.
2nd day—Putty.
3rd day—1st coat of an approved coating, standard shade.
4th day—No operation (dry).
5th day—Finishing coat of color or enamel, standard shade.
6th day—Paint steam coil and guards and do necessary stenciling.

Six days to be consumed to finish this class of car, followed by one day for trimming, and O. K. on the 8th day.

CLASS "C" REPAIRS

Steel or Wood Dining or Private Cars and Coaches

Car to be washed.

After necessary repairs are made the following treatment to be accorded:

Outside of car, new or bruised parts touched up with primer and surfacer, puttied, sandpapered, spot colored and given a coat of color all over, cutting in around lettering, numbering, etc.

Apply one or two coats of varnish according to Railway Company's standard.

Roof to receive one or two coats of standard roof paint.

Deck to receive one or two coats of body color in oil, or standard roof paint, according to Railway Company's standard practice.

Trucks, battery boxes and underneath work, one coat of an approved oil paint.

Platforms, one coat of enamel.

Inside Operations.

If wood, touched up and given only sufficient operations to make presentable and maintain Railway Company's standard.

If steel, touched up and given only sufficient operations to make presentable and maintain Railway Company's standard.

Six days consumed to finish this class of cars, followed by one day for trimming, and O. K. on the 8th day.

We would recommend that cars having received Class "A" repairs be returned to the shops to receive Class "C" repairs after service of twelve months.

Cars receiving Class "B" or "C" repairs should be returned to the shops at the expiration of 18 months.

This report is signed by: D. C. Sherwood, N. Y. C.; A. E. Green, C. & N. W.; J. R. Ayers, C. P.

REPORT OF COMMITTEE ON SAFETY AND SANITATION

The safety devices in and around railway paint shops is a matter that should interest and attract the co-operation of every man employed. While it is not usually considered a hazardous occupation, nevertheless certain elements of danger enter into the trade and should be carefully checked and, in so far as possible, eliminated.

The scaffolding in our modern shops should be so constructed as to guard against any possibility of collapse; and if mechanical in action, certain absolute devices should be attached to make them sure and safe. All fires, such as open torches or portable furnaces, should be excluded from the paint shop, for the nature of the materials used are of volatile and spontaneous mixtures and easily ignited. Nearly every paint shop fire has been directly traceable to this source.

The protection of employees when working on cars in repair yards is important, and the tracks should be equipped with caution signs of an absolute character. If possible, switches leading to repair tracks should be locked and a

blue flag displayed reading "REPAIR MEN." These flags should not be removed except by those directly in charge of the gangs who are doing the work. Each man should be instructed to see to it that such protection is in place before proceeding with his work. Most railroads make this rule imperative when employing men.

Workmen who are asked to clean and scrape rust off of steel cars should be furnished with goggles for eye protection. Chain hoists used for handling and unloading barrels, etc., should receive frequent inspection. Stepping on nails is very frequent and sometimes results in serious consequences; it is therefore very essential that rubbish of all kinds be removed and deposited in receptacles specially provided for this purpose.

Sanitation

Sanitation of shops and surroundings is one of the most paramount features necessary to establish an efficient organization. Nothing so impairs the efficiency of men as unhealthy surroundings. Very frequently better places are discarded or left vacant than buildings erected for men to work in. The purpose of this report is to point out some few conditions which would tend to weaken an organized body of men and thus lessen their efficiency, and suggest a few more favorable conditions which would tend to build up a healthy, happy and efficient group of workmen.

The buildings, in so far as possible, should be made and placed so as to guard against unsanitary conditions, furnished with good sewage, plenty of air spaces, well ventilated and sufficient heat units to keep the temperature even. Doors and windows should be so placed as to guard against insufficient circulation of fresh air at all times. If possible, all openings should be screened in order to keep out the dreaded germ carriers. Floors should be so constructed that water will drain off, thus preventing a possibility of breeding places for mosquitoes, etc. A room measuring 18 ft. by 24 ft., making a floor area of 432 sq. ft., should contain four windows measuring 3 ft. by 6 ft., a total window area of 72 sq. ft. Natural illumination is that provided by the direct rays of the sun or light reflected by the sky. In factories, workshops and other places in cities where daylight illumination is reduced by the walls of neighboring buildings, an increased illumination may be obtained by the use of ribbed glass, which causes a larger portion of the light to be refracted into the building. Windows should always be kept clean, as the amount of light entering the room may be reduced 40 per cent by dirt upon the glass. With modern illuminating units and suitable reflectors a current consumption of about one watt to each square foot of surface should yield an intensity of four-foot candles. Every effort should be made to prevent a glare, as glare makes seeing difficult and soon impairs the eyesight, thus further interfering with the efficiency of the workmen.

Dust is the arch enemy of the paint-shop workman. It may be of organic or inorganic origin. The inorganic dust is what is most dangerous, and we must guard our workmen against the dust from the sand-blast machine. For dust from this source is severe on the throat and lung tissues. There are numerous ways to accomplish this. Somerfeld, in the following table, gives some idea of the injurious effects and the death rates per thousand from consumption of persons engaged in various trades where dust is a prominent factor:

Occupation without dust production	2.39
With dust production	5.42
With porcelain dust	14.
With iron dust	5.55
With lead dust	7.79
With stone dust	34.09
With stone workers	4.03
With wood and paper dust	5.96
With tobacco dust	8.47

Dust containing sharp, gritty particles, such as present during cutting of hard rock, sets up a chronic irritation of the air passages which then become favorable lodging places for the germs of consumption and kindred diseases. The bad effects of dusty working places may be obviated by the use of respirators. These are, however, rather uncomfortable to wear, so the better way is to remove the dust at its source by some mechanical device or prevent its accumulation in the air by the use of water.

Those who are compelled to work in white lead should use great precaution regarding cleanliness. A workman should never eat or handle food without first thoroughly cleansing his hands, for lead is more often carried into the system through this process than in any other way. Lead poisoning has become so great a menace among workmen that the State Boards of Health and Labor Bureaus are making a very exhaustive examination of the causes and prescribing ways and means of averting its ravages.

Painters stenciling cars where it is necessary to hold the stencils with the fingers should use some form of protection. The use of finger ends from rubber gloves is a simple and effective expedient. Dr. Robert Jones, reporting in 1900 upon 3,500 males admitted to the London county asylum for the insane, found among them 133 artisans who had been exposed to plumbism; painters, 75; decorators, 13; plumbers, 18; gasfitters, 13; laborers in lead, 6; grainers, 3; gas meter makers, 2; color grinders, 1; file cutters, 1, and tea lead rollers, 1. It seems that whatever we can do to allay the possibility of lead poisoning should, by all means, be done.

There are only two ways to come in contact with paint and its effect on the health of men: by actual physical contact, and by inhalation; and both of these can be almost entirely eliminated, one by the painter himself and the other by shop construction. The careful painter will always avoid getting paint all over his hands and face, and we should see to it that the other, ventilation, is given him.

Paint Spraying Machines

The spraying machine is one of the most economical and efficient means of applying paint to all freight cars, running parts of locomotives, trucks and underframes of passenger cars. It is the experience of the committee that a freight car can be painted at about one-fourth the cost for labor by use of a spraying machine. The cost of labor saved is not the only item to be considered. Freight cars can not be painted until after repairs are completed, and to maintain a force of painters of sufficient size to paint cars by hand after cars are repaired would mean that during a large part of the day these painters would be idle. By using spraying machines a small force of painters can do the work and can be profitably employed during the early part of the day at necessary small jobs.

Since the spraying machine is both economical and efficient, we should use all means to overcome the only possible objection to it, make its use free from fume effect. We would suggest that all work be done out of doors as much as possible. Freight cars can be and usually are painted under a shed, and many shops do not even have a shed. The next thing is to use a spraying machine with a long barrel or "gun" that not only makes the use of scaffolds unnecessary but puts the paint up close to the work and away from the operator.

The report is signed by: W. A. Buchanan (chairman), D., L. & W.; J. S. Gilmer, Southern; C. D. Beyer, L. & N.

Machinery Exports Treble in Six Years.—In 1913 the total exports of machinery were valued at $127,980,000, while in 1919 they reached a total value of $378,425,000. That the total in the latter year was not greater was due to the urgent home demands for machinery of almost every description, which limited the amount available for export. One large manufacturer declared recently that his foreign orders for the first six months of the present year were more than 60 per cent greater than during the same period last year.—*The World Markets.*

Banquet of the Tool Foremen's Association

Convention of the Tool Foremen's Association

Standard Staybolt and Boiler Taps Agreed Upon; Proposal to Amalgamate With A.R.A. Sec.III Adopted

THE American Railway Tool Foremen's Association is the second of the so-called minor mechanical department organizations to take definite action on the question of amalgamation with the American Railroad Association, Section III—Mechanical. The Association voted definitely to accept the invitation of Section III—Mechanical to become a part of that organization, at the tenth annual convention, which was held at the Hotel Sherman, Chicago, September 1, 2 and 3.

The convention was called to order by the president, J. C. Bevelle (El Paso & Southwestern) and, following the usual opening exercises, proceeded immediately to the consideration of the technical reports and papers on the subjects assigned for investigation at the last convention. Abstracts of the papers and the discussion which took place at the meeting are given below.

J. C. Bevelle
President

J. B. Hasty
First Vice-President

G. W. Smith
Second Vice-President

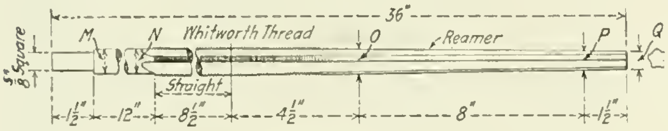
R. D. Fletcher
Secretary-Treasurer

STANDARDIZATION OF BOILER AND STAYBOLT TAPS

Fig. 1 shows a 36-in. tap with Whitworth threads, 12 per in., which is carried by tap manufacturers throughout the United States in regular stock. There is also made, to the same standard, spindle tap and spindle which is used for the same purpose as the 36-in. tap. This tap, known as style two, has been used to good advantage for applying staybolts back of the frame. These taps are 12-thread Whitworth and are manufactured by the S. W. Card & Company, or by Charles Besly & Company. Our reason for recommending the adoption of these taps is the fact that they are at present used successfully on many railroads and are giving better results than other types. The Whitworth thread has a greater tensile strength and maintains its original

diameter longer than the V or the United States Standard forms of thread.

A standard 24-in. staybolt tap is also required. This tap is also 12-thread Whitworth. These taps are at present carried in commercial lengths of 21 in., 22 in. and 24 in. We recommend the 24-in. tap because the reamer portion is extra long, giving a greater length and smaller diameter on the point, so that, when tapping from the outside, the small end of the tap protrudes through the inside sheet and acts as a guide, making it much easier for the operator and assuring a good thread on both the outer and inner sheets. The taper threaded portion of the tap has been lengthened,



Size of Tap	Threads to inch	M	N	O	P	Q
15/16"	12	13/16"	15/16"	13/16"	11/16"	5/8"
1"	12	7/8"	1"	7/8"	3/4"	11/16"
1 1/16"	12	15/16"	1 1/16"	15/16"	13/16"	3/4"
1 1/8"	12	1"	1 1/8"	1"	7/8"	13/16"
1 3/16"	12	1 1/16"	1 3/16"	1 1/16"	15/16"	7/8"
1 1/4"	12	1 1/8"	1 1/4"	1 1/8"	1"	15/16"
1 5/16"	12	1 3/16"	1 5/16"	1 3/16"	1 1/16"	1"

Fig. 1—Radial Staybolt Tap

making the life of the tap much longer as well as eliminating a great deal of wear and tear on the air motor and consequently making it easier on the operator. We recommend that these taps be furnished in sizes from 15/16 in. to 1-5/16 in., advancing by sixteenths if possible. We find that these sizes will conform to the government rulings, making 15/16 in. the smallest bolts and 1-5/16 in. the largest. These taps are all to be 12-thread Whitworth and should be furnished over-size with a minimum of .0015 in. and not to exceed .0035 in. This will take all standard makes. The number of threads per inch should be 12 and in a distance of 6 in. there should not be more than 60¼ threads or be less than 59¾. The staybolt cutting machine should be checked very closely and the diameter kept to a standard so that the threads cut on the staybolt will be as accurate as the tap.

Fig. 2 shows a standard button head radial staybolt tap.

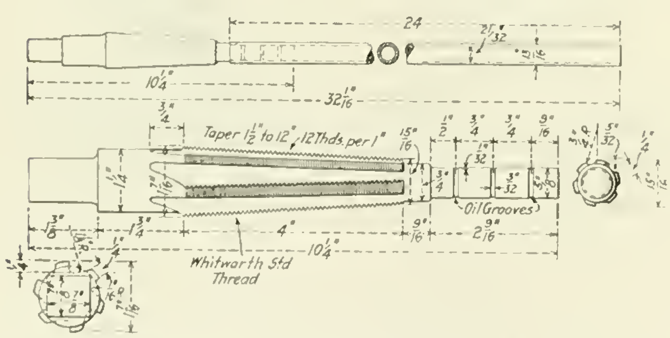
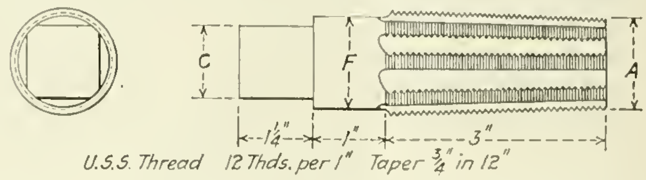


Fig. 2—Button Head Radial Staybolt Taps

This tap is now commercially manufactured and is used very successfully on many railroads. It has a taper of 1½ in. in 12 in. and is 12-thread Whitworth. This tap is used for applying button head radial staybolts in the crown sheets of locomotives.

Fig. 3 shows boiler head and washout plug taps. These taps should be tapered ¾ in. in 12 in. and have 12 threads per inch, United States Standard. One taper and one thread should be maintained in all washout and mud plug holes. It has been found that taps made with this taper give excellent results, not only assuring a good tight plug, but one that is safe. We find that ¾-in. taper in 12 in. is far more desirable than 1½ in. and believe that it will eliminate the blowing out of washout plugs.

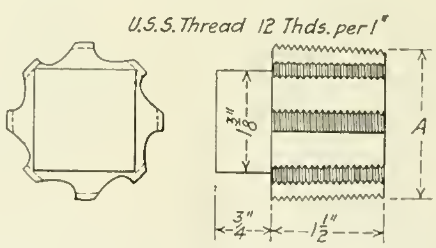
Fig 4, shows a special washout or mud plug tap. This is only used in emergencies or in roundhouse service where it



No.	A	C	F	Flutes	No.	A	C	F	Flutes
10	1 1/4"	1"	1 3/16"	5	24	3"	2"	2 7/8"	8
11	1 3/8"	1"	1 3/16"	5	25	3 1/8"	2"	2 7/8"	8
12	1 1/2"	1"	1 1/4"	5	26	3 1/4"	2"	2 7/8"	8
13	1 5/8"	1"	1 1/4"	5	27	3 3/8"	2"	2 7/8"	8
14	1 3/4"	1"	1 3/8"	5	28	3 1/2"	2 1/4"	3 1/4"	8
15	1 7/8"	1"	1 1/2"	6	29	3 5/8"	2 1/4"	3 1/4"	10
16	2"	1 3/8"	1 7/8"	6	30	3 3/4"	2 1/4"	3 1/4"	10
17	2 1/8"	1 3/8"	1 7/8"	6	31	3 7/8"	2 1/4"	3 1/4"	10
18	2 1/4"	1 3/8"	1 7/8"	6	32	4"	2 1/4"	3 1/4"	10
19	2 3/8"	1 3/8"	1 7/8"	6	33	4 1/8"	2 1/2"	3 5/8"	10
20	2 1/2"	1 3/8"	1 7/8"	8	34	4 1/4"	2 1/2"	3 5/8"	10
21	2 5/8"	1 3/8"	2 1/4"	8	35	4 3/8"	2 1/2"	3 5/8"	10
22	2 3/4"	1 3/8"	2 1/4"	8	36	4 1/2"	2 1/2"	3 5/8"	10
23	2 7/8"	1 3/8"	2 1/4"	8					

Fig. 3—Boiler Head and Washout Plug Tap

is not possible to insert a standard length tap. These taps conform to the standard tap with the exception that they are not as long. Fig. 5 shows boiler stud and patch bolt taps. These taps have ¾ in. taper in 12 in., United States Standard form of threads, and run in such sizes that one tap will fol-



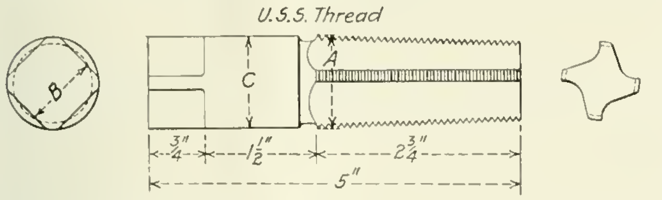
No.	Diam. at A	Taper	Where Used	Remarks
1	2"	3/4" in 12"	Corner Plug back of Frame	
2	2 1/8"	" "	" "	
3	2 1/4"	" "	" "	
4	2 3/8"	" "	" "	

Fig. 4—Special Washout Plug Tap

low the other, the sizes being designated on the large end. The taper tap is recommended instead of the straight tap for boiler studs for the following reasons: First, we can get a more secure stud with the taper thread tap than with the straight thread tap; second, there is less liability of a leaky stud. It must be understood that when taper studs are applied they must penetrate the sheet. It is now the practice on many railroads to use a tap similar to the one described.

If these taps are adopted as standard they will eliminate

many irregularities that now exist on the railroads throughout the United States. Furthermore, it simplifies the manufacturing of taps for this particular class of service. At present these taps can be secured from any first-class manu-



No.	Threads Per Inch	Taper in 12"	A	B	C
A	12	3/4"	7/16"	7/16"	1/2"
B	12	3/4"	9/16"	1/2"	5/8"
C	12	3/4"	5/8"	1/2"	5/8"
D	12	3/4"	11/16"	1/2"	5/8"
E	12	3/4"	3/4"	1/2"	3/4"
F	12	3/4"	13/16"	1/2	3/4"
G	12	3/4"	7/8"	3/4"	7/8"
H	12	3/4"	15/16"	3/4"	15/16"
I	12	3/4"	1"	3/4"	15/16"
J	12	3/4"	1 1/16"	3/4"	1"
K	12	3/4"	1 1/8"	3/4"	1"
L	12	3/4"	1 3/16"	3/4"	1"

Fig. 5—Standard Patch Bolt Tap

facturer at a much more reasonable price than they can be manufactured locally in a railroad shop.

The report was signed by E. J. McKernan (chairman) W. Wood, W. Perkins, J. N. Meek and H. E. Barnes.

Discussion

The question of what type of thread for staybolt taps will give the best results brought out a general discussion. The comments of the members indicated that comparatively few railroads have adopted the Whitworth thread recommended by the committee, while about an equal number appeared to be using the V thread and the United States Standard thread. Expressing their personal opinions, however, few of the members considered V threads as satisfactory as either of the other two kinds and the prevailing sentiment indicated that the Whitworth is the most desirable of the three types. Tests were referred to in which the pulling strength of the Whitworth type in the sheet has been demonstrated to be greater than either of the other two forms and the circular shape of the cutting edges of the Whitworth tap is less affected by wear than either of the other two, both of which have sharp corners. Taps with the V thread have been found to lose as much as .003 in. in diameter in tapping one hole under the heavy drive which these taps must withstand under modern conditions. Where a railroad makes its own taps, however, which is frequently done in the case of the plug and stud taps, either the United States Standard or the V type threads are more easily formed. For this reason the committee recommended the United States Standard type for plugs and stud taps.

HEAT TREATMENT OF STEELS

Heat treatment is the most important operation that our tools have to pass through. Shop output depends very largely on the quality and quantity of small tools. To get maximum shop output every tool and machine must be giving maximum production, which means that it is completing its operation in the shortest possible time and is keeping this up for a maximum period of time. These two factors are dependent one upon the other. If we operate a machine at too high speed or too great a depth of cut, resulting in excessive wear or breakage, the time consumed in changing, re-setting or repairing overbalances the time gained by the increase of speed or depth of cut.

The moral effect on the men in the shop of properly heat treated tools goes farther toward getting a maximum shop output than any of us can imagine. It is a factor which cannot be expressed very easily by figures. We have absolute control over the design of the tool, but can we say what its performance will be after it has been treated and ground up ready to put in service? If we have the proper equipment we can say yes for a very large per cent of our tools.

To obtain the best possible results from the heat treating plant there should be a spirit of close co-operation between it and the department using the tools. In other words, the one in charge should have a thorough knowledge of their performance in service. The best way for this condition to exist is for the tool foreman to have actual charge of the treating plant. This has been done in a great many shops. The heat treating plant should be in the manufacturing department, which would reduce the lost motion and the overhead charges in transporting tools to and from the heat treating furnaces.

HEAT TREATMENT

Owing to the general makeup or composition of tool steel, which is unlike pure iron or other similar metals, it must be properly and carefully handled in the heat treatment to obtain best results and prevent losses.

There are three general heat treatment operations: annealing, hardening, and tempering. In all of these the object sought is to change in some manner the existing properties of steel; in other words, to produce in it certain permanent conditions.

The controlling factor in all heat treatment is temperature. Insufficient or excessive temperatures do not produce the results sought. Excessive temperatures, either through ignorance of what the correct point is or inability to tell when it exists, may cause burned steel. This is a common failing, resulting in great loss. Slight variations from the proper temperature may do irreparable damage. Steel that has been burned is useless and cannot be restored by annealing.

In the actual heating of a piece of steel several requirements are essential to good hardening. First, the small projections or cutting edges must not be heated more rapidly than is the body of the piece; second, all parts must be heated to the same temperature, as low as will give the required hardness to produce the best results.

Any temperature above the "critical point" of steel tends to open its grain, to make it coarse and to diminish its strength. The temperatures at which the internal changes in structure of steel take place are frequently spoken of as the "critical" points. These are different in steels of different carbon contents. The critical points may be observed by watching closely the slow heating of a piece of steel in the furnace. At first the temperature of the steel gradually increases with the heat of the furnace until a point is reached at which it appears a little darker and cooler than the furnace, then as heating continues the piece again assumes the color and temperature of the furnace. This critical point is termed "decalescence." A similar change may be noted in cooling down the furnace, during which process at some point the piece of steel may become brighter and apparently hotter than the furnace, and later assume again the temperature of the furnace. This is known as the "recalescence" point. The temperatures of the critical points are usually dependent on the percentage of carbon.

Great care should be exercised in heating tool steel for forging as well as hardening or tempering; this is especially

true of high speed steel. Take sufficient time, depending on the size of the piece, to give it a thorough soaking heat, up to the proper temperature, but do not overheat.

The exact treatment varies for different steels and it is usually advisable to follow the directions given by the steel makers.

METHODS AND EQUIPMENT FOR HARDENING AND TEMPERING

It has not been long since heat treating as well as forging and dressing tools was entirely handled in the blacksmith shop by old methods. Results depended on the ability of the tool smith and the attendant varying conditions. The principal factor, temperature, was governed by observation of the color both when hardening and drawing. Today most of the railroads are using up-to-date methods and equipment, especially in their large shops, where centralized manufacture of tools is carried on.

Unquestionably the proper location for heat treatment of tools at shops where any considerable amount of this work is done, is in the tool room. It is important that, in order to handle this work successfully, the men in charge have a knowledge of the material and proper methods of handling, and be provided with the suitable equipment, such as furnaces, heat gaging apparatus, hardness testing instruments and so forth.

There are several types of furnaces which may be used for heating tool steel and the kind selected would depend considerably on the shop conditions and the kind of fuel available. Good results are obtained from furnaces using electricity, gas, oil or hard fuel, such as coke or coal, as heating mediums; the first two mentioned are no doubt the most popular and efficient for tool work. Any fuel-burning furnace for this work should be so constructed that the flame does not come directly in contact with the article to be hardened. This can easily be arranged through use of a combustion chamber in connection with suitable design and construction of the heating chamber. There are several different designs which may be used for each of the different fuels, but they all should produce as nearly as possible the ideal condition for the heating chamber where the wo'k is placed. The size will be governed by the amount and size of the articles to be hardened.

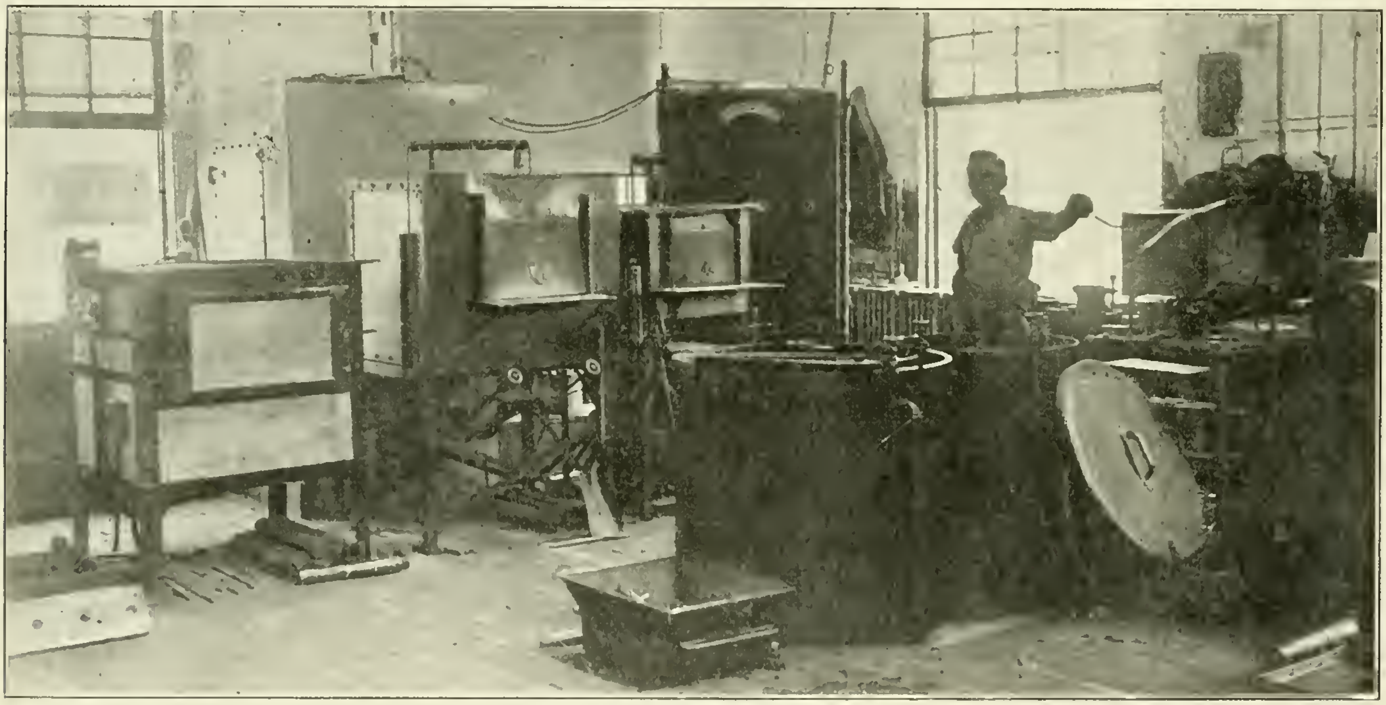
Some of the best builders of furnaces today are prepared to furnish very desirable equipment, either standard or built to specifications, and there is available complete matter in the way of description and prints on both the electric furnaces and those using other fuels, so we will not take space here to describe each in detail.

The nature of the work, the size or shape of piece to be hardened, makes desirable at times the use of different processes or kinds of heating mediums, as, in addition to the plain electric, gas, oil or coke oven, the bath furnace is found very convenient for long articles, such as stay bolt taps, long reamers, etc. The material used for the bath usually is lead, or a salt mixture, such as barium chloride, etc., each having some advantage over the other. This form of hardening is much in favor for a lot of work done in the tool room, on account of the ability to heat only that portion of the tool desired, and exclude all air from the heated part, thereby eliminating danger of scaling, which exists with almost any other means of heating.

The quenching of the heated article is an important operation and in too many cases is not given the consideration and attention it should receive. The tanks should be of ample size and it is often necessary, if much work is done, to have more than one in order that the quenching liquid may be maintained at an even temperature. The uniform hardening of heating tools depends greatly on the uniform temperature of the quenching mixture and, where one tank or more is used, a good arrangement is to have the quenching tank inside of another tank of water and to keep the quenching medium stirred up by air through a submerged pipe or by mechanical means. Oils, brine and clear water are used as quenching mediums, and the temperature may be raised or lowered as desired by means of steam or water pipes, but it should be kept uniform for each batch of tools and for all similar work.

In the hardening operation the steel should be quenched on the rising temperature.

The use of air for hardening high speed steel is also necessary in addition to the liquid and it is best to have a good valve in connection with a compressed air line to regulate the pressure.



Hardening and Tempering Room, Illinois Central, Burnside Shops, Chicago

For some time past the oil bath has been generally used for drawing back and it is preferable to the old way of drawing by observing the color of the tool. There is also in use for this purpose the electric oven, which is comparatively new and in several ways superior to other equipment for this work.

TEMPERATURE MEASUREMENT

In all the heat treatments of steel, and especially the heating of tool steel for forging, hardening or drawing, the most valuable asset of the hardener is the knowledge of proper temperatures for the various kinds of steel and a sure and convenient means of determining those temperatures. The information regarding the proper temperature for a certain kind of steel is easily obtained and it is considered good practice to follow the instructions of the steel manufacturer for his product. The only safe way to measure or determine the temperature in the future or bath is by the use of good electrical or optical pyrometers. The practice of depending upon the naked eye to tell the temperature of a furnace or a tool by its color is not productive of good results, no matter what kind or how good the steel may be.

Pyrometers may be used in connection with almost any kind of furnaces and it is well to have a master pyrometer for comparison in checking the service instrument. These are not complicated nor expensive devices when compared with the service they render. They are, however, somewhat delicate and should be handled accordingly. The pyrometer may be tested for correctness by the simple salt-cooling process, or will be calibrated by the manufacturer or by the United States Bureau of Standards for a nominal sum. The pyrometer must be kept accurate at all times, as variation either way of several degrees would render it as good as useless for temperature determination; therefore, check your instrument frequently.

HARDNESS MEASUREMENT

There is still another instrument which, by all means, should have its place in the complement of equipment for heat treatment of tool steel. This is the scleroscope. There are other methods of testing the hardness, which no doubt are equally as good for some kinds of work, but the scleroscope seems to be best suited for tool room use. There should be a record kept of the heat treatment of all tools made. This may best be in the form of a card record for ready reference and should contain such information as kind of tool, make and grade of steel, temperature given for hardening, time in furnace, quenching medium used, drawing temperature and time, and scleroscope hardness. To this may be added remarks relating to the performance of the tools in service.

This will be very valuable information for the tool man. It will enable him to make corrections from time to time in the treatment of steel, or of defects which may be a result of having it too hard or too soft for the purpose for which the tool is used. The report was signed by C. A. Shaffer (chairman), H. Otto, P. Renfrew, W. J. Hines and F. C. Courson.

Discussion

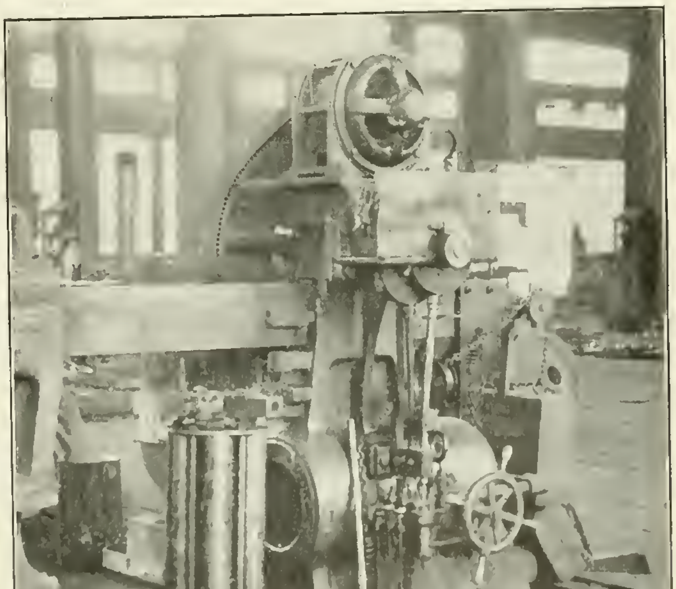
During the discussion, Professor Kinsey, of Stevens Institute of Technology, Hoboken, N. J., gave an interesting talk on the principles of heat treatment of steel, bringing out clearly why uniform results cannot be expected from tools which are heat treated in the open fire of the blacksmith's shop and the eye depended on to measure temperature by color determination. Professor Kinsey pointed out that the transformation which causes hardness on quenching takes place at the decalescent point, which occurs within the narrow range of about 54 deg. If this temperature is not reached the complete transformation will have not taken place, while, on the other hand, if this temperature is exceeded a change takes place which immediately begins to increase the grain size thereby seriously weakening the material. He pointed out the practical impossibility of accurately determining temperature within this narrow limit by color determination, which is effected by changes in the light of the shop.

The fact that there are not as many skilled toolsmiths at the present time as used to be employed in the blacksmith shop was mentioned as an additional reason why suitable furnace equipment fitted with pyrometers is more essential now than ever before if satisfactory tool service is to be obtained. Where this work is specialized it is not essentially a blacksmith's job, as a good heat treater need know nothing about the details of the blacksmith trade.

The importance of careful attention to furnace conditions was also touched on from several different angles. Several cases were mentioned where failure to secure proper hardness was experienced, for which there seem to be no apparent cause. The discussions indicated that these cases are frequently due to carbonization of the surface of the material cause by the flame playing on the tools. This frequently insulates the material, thus preventing a uniform temperature being attained throughout the piece. Similar results have been caused by oxidization or de-carbonization of the surface, thus producing a soft exterior which can only be corrected by removing the surface metal and rehardening under proper conditions. Burned steel has also been found to be more the result of improper furnace conditions than of the actual temperature to which the material has been heated. If oxidization can be prevented the temperature has little effect on steel which cannot be removed by annealing and retreating.

JIGS AND DEVICES FOR LOCOMOTIVE AND CAR SHOPS

At the Roanoke, Va., shops of the Norfolk & Western, a 300-ton wheel press, with 13-in. ram, unexpectedly developed a bad place in the copper lining and a new liner had

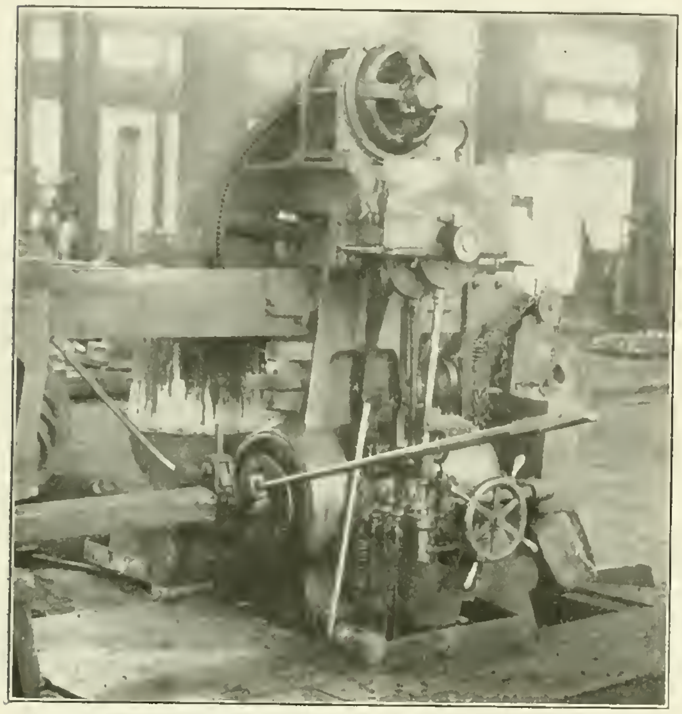


Rollers for Applying Copper Lining to Wheel Press Cylinders

to be rolled in place at once. The part of the press to be worked on was brought to the machine shop and placed on the table of the locomotive cylinder boring machine and

rollers with 2-in. faces were placed in the tool slots of the boring head, with a taper pin in the center to expand the rolls uniformly.

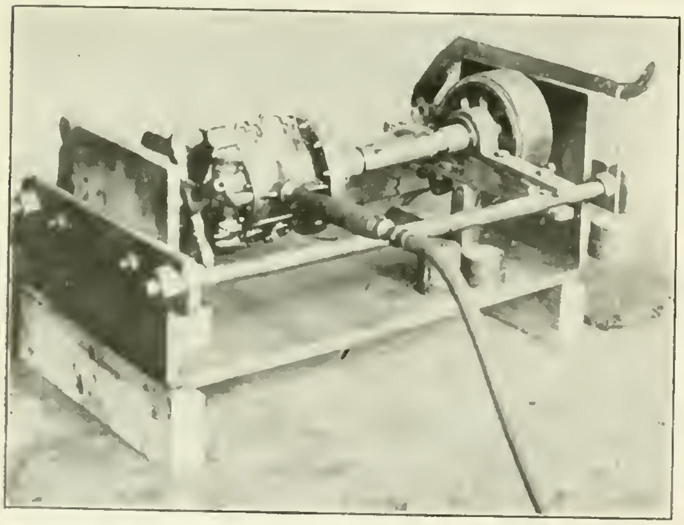
The work proceeded nicely while feeding in on the first rolling, but on feeding out it was discovered that the liner was stretching and moving out and, when complete, the job was not as satisfactory as could have been desired, due to the



Method of Operating the Rollers

creeping of the material as the rolls passed over the surface.

As a result of this experience a roller was made having five rolls, $4\frac{1}{2}$ in. in diameter at the large end and extending into the cylinder 31 in., the entire depth of the copper liner, with a taper of $\frac{1}{8}$ in. in 12 in. A taper pin of sufficient



Prony Brake Used for Testing Air Drills

diameter to expand the rolls the required amount was operated by a ratchet lever and bar, and forced between the rolls with the aid of the twin ram at the other end of the press.

With this device the liner was rolled into place in a very satisfactory manner by simply removing the ram and the old copper liner and inserting the new liner and putting the roller in service. The work was finished in perfect condition and ready for service in five hours.

TESTING PNEUMATIC DRILLS FOR PULLING POWER

When a pneumatic drill has been sent to the shop for overhauling, there should be some method of determining whether it has been improved by the operation and what per cent of its normal power it is exerting. In order that the machines could be checked before leaving the shop the ap-

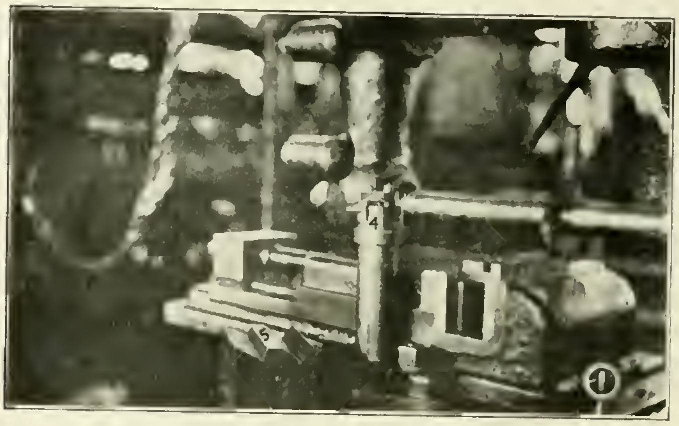


Fig. 1—Milling the Grooves in Flue Cutter Knives

paratus shown in the photograph was designed for use at the Roanoke shops of the Norfolk & Western.

It consists of a spindle and brake wheel in a frame, to which the drill can be attached in the manner and with the same effect as when drilling a hole. The brake lever can be loaded to get any desired resistance within the capacity of the machine.

By making a record of each class of drill when new, it is always possible to determine what per cent of its rated capacity it is exerting.

MAKING FLUE CUTTER KNIVES ON A MILLING MACHINE

Flue cutter knives which were formerly made at the Battle Creek, Mich., shops of the Grand Trunk, partly by machinery and then finished by hand, are now made entirely

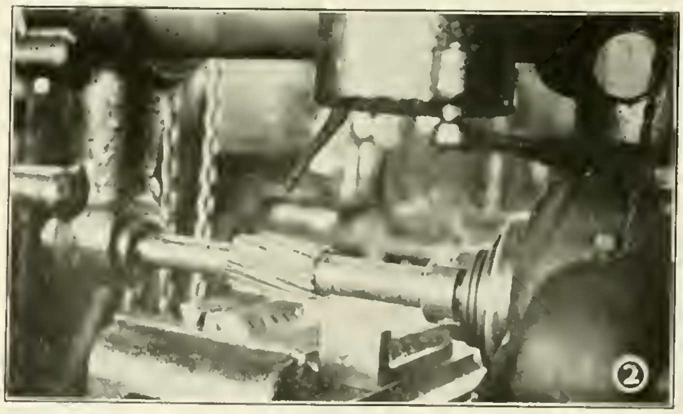


Fig. 2—Milling the Angles on Flue Cutter Knives

in the milling machine and the time required has been reduced about one-half.

The first operation is to cut the bar stock in suitable lengths to make about twelve knives. The square stock is then put in centers and straddle mills are used to mill to the required size, which is $\frac{3}{4}$ in. square. Then the stock is cut to the proper length to make the knives. The grooves are then milled in, as shown in Fig. 1. After this operation

is finished, the knives are put in a vise, using the device shown in Fig. 2, and the angles are milled. The rack cutting attachment is then used, as shown in Fig. 3, placing the knife in the device as shown and using twin mills to cut the point down to the proper width. The device is placed in the vise on the index head and the tail stock center is used as a clamp, using the index handle to turn the head.

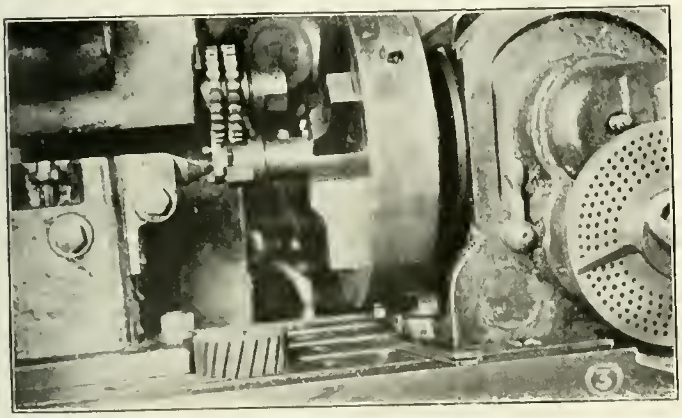


Fig. 3—Milling the Cutting Edges of Flue Cutter Knives to Width

After the points are milled, the straddle mills are removed, another cutter put on, and the other ends milled to the proper circle.

The papers on this subject were prepared by the following committee: J. J. Sheehan, chairman; P. L. Watson, J. J. Sumner, Thos. Bell and R. E. O'Hern.

Discussion

Following the presentation of the papers on this subject it became evident from the discussion that there are few tool foremen who do not have a number of special devices which they have developed for various operations in their shops. The importance of this field as a matter for the systematic consideration of the tool foreman was stressed by several members. The future of the tool room foreman lies, not in his ability to turn out satisfactory small tools and machine tool cutters, but in the extent to which he studies the problems of the other departments of the shop with a view to the development of special jigs and tools to reduce the time and labor required on machine and erecting floor operations.

ISSUING AND CHECKING TOOLS IN LOCOMOTIVE AND CAR SHOPS

BY J. B. HASTY,
A. T. & S. F.

Employees entering the service are required to sign a card form in duplicate. The original is retained by the foreman and the duplicate by the employee. Six tool checks, a hammer, monkey wrench and three chisels are furnished and entered on his card, which he retains until he leaves the service. The main tool room is located in the center of the machine shop. There are also sub-tool rooms in the boiler shop and car shop. All new or repaired tools are distributed to the sub-tool rooms from the main tool room. All small hand tools are grouped in racks with the sizes stenciled on the racks; small hooks are provided to hang the checks. Checks must be presented for all tools in the tool room, except chisels and machine tools. A supply of these is kept in the tool room and exchanged as they require redressing.

When chisels become too short for further use as chisels, they are made into center punches, drill drifts and other small tools. Machine tools are of standard sizes and when two-inch by three-inch tools become too short for further use, they are made into smaller sizes until they are worked down to ¼ in. by ¼ in. for Armstrong tool holders. Tools that require redressing are delivered to the smith shop each morning and returned to the tool room in the evening, ground and placed in racks for distribution. Pneumatic tools are returned to the tool room each evening for inspection and oiling. All tools must be turned in before quitting time on Saturday. A record is made of all checks left in the tool room over Sunday and the employees involved are taken to task for not obeying rules.

Shop goggles are kept in an inclosed case, checked out and sterilized as they are returned. If tools are lost, broken or damaged by an employee, he is required to get a clearance card properly signed by his foreman before his check is returned to him. An employee leaving the service is required to return the tool checks and tools recorded on his card to the tool room foreman, who checks them up and, if there is no shortage, signs the order for his time. In case of a shortage, explanation is demanded and unless he can give a good reason for the shortage the cost of the missing tools is deducted from his pay.

Discussion

Most of the members who took part in the discussion of this paper are using systems of issuing and checking tools similar to that described, varying in details or supplemented by periodical inspections of cupboards as a check on the operation of the system. In some cases, instead of permanently assigning cutting tools to the men, they are assigned to the machine, with a supply in the tool room for the use of men on the night shift. The importance of the tool room foreman securing the confidence of the men and of the other foremen was touched on by several members. This is necessary in order to secure the co-operation of the men in returning the tools to the tool room at the end of the job or of the day, according to the rules of the shop, and to insure that the foremen will not let irregularities pass unnoticed. In one case the monthly inspection of the shop made by the local safety committee is also utilized to locate broken and misplaced tools. To avoid the opportunity of forgery an annual change in the form of tool checks is also made in some cases.

Other Business

During the second session of the Convention H. H. LaVercombe, President, Tool Salvage Company, Detroit, Mich., described what is being done by his company in salvaging worn out milling cutters by a secret grinding process, without the necessity of heat treatment. He also referred to the method of restoring slightly worn straight flute reamers to size by a hot pressing process developed by his company.

During the closing session of the convention a moving picture showing the proper use and the abuses of twist drills was shown by the Cleveland Twist Drill Company.

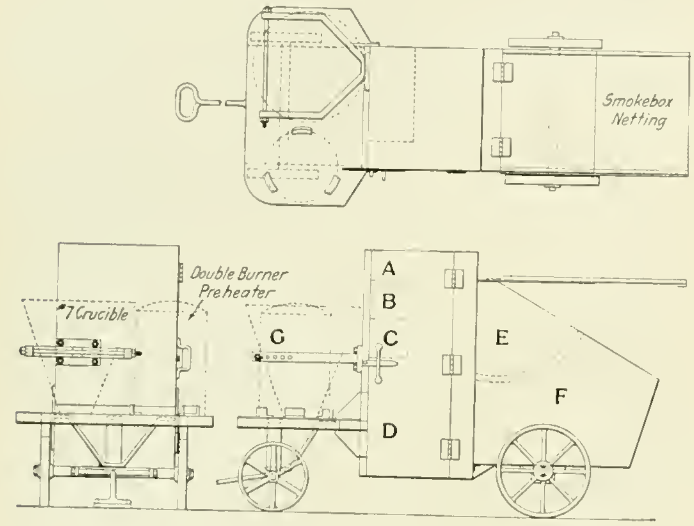
The following officers were elected for the coming year: President, J. B. Hasty (A. T. & S. F.); first vice-president, G. W. Smith (C. & O.); second vice-president, Charles Helm (C. M. & St. P.); third vice-president, Geo. Tothill (B. R. & P.), and secretary-treasurer, R. D. Fletcher (Crucible Steel Company). The following were elected members of the executive committee: P. Renfew (Big Four), chairman; T. W. Henson (Wabash), E. A. Westerman (Indiana Harbor Belt), C. Dangelmeyer (C. M. & St. P.) and C. C. Kuyper (Illinois Central).

The association voted to hold the next convention at the Hotel Sherman, Chicago.

Railroad Construction in Central America:—Negotiations for a railroad connecting Guatemala City and Salvador which were suspended during the war, have now been resumed. The projected road will extend from Zacapa southward 157 miles to Salvador. About three years will be required to complete the work.

TOOL WAGON FOR THERMIT WELDING MATERIALS

The accompanying sketch shows a new and improved tool wagon for holding all materials and appliances for thermit welding which has been designed by the Metal and Thermit Corporation, New York. The new design provides a place for the thermit preheater at the side of the crucible. The tool wagon also contains a tool box for all necessary tools, space for mold boxes and a bin for molding material divided into two parts, the upper one for facing material and the lower for backing material. A sand screen is provided in the lower part of the lid for screening molding material when a mold is broken up to prepare it for the next weld. During the screening of sand this lid is closed.



The Wagon Carries Everything Needed for Making a Thermit Weld

The following list shows the arrangement of the parts in the wagon:

A—Drawer for spring balance, hammer, chisel, monkey wrench and Stillson wrench.
B—Shelf for bolts and nuts, nail puller, double-end wrenches, leaf and long spoon, thimbles, ignition powder and gloves.
C—Shelf for trowel, lifter, screwdriver, pliers, slick, plugging material and vent wire.
D—Compartment for crowbar, hot blast furnace, gas, torch, rammer, mold box parts, patterns, shovel, sledge, wax in box, flaming burner and crucible holder.
E—Compartment for facing sand.
F—Compartment for molding sand.
G—Adjustable clamp for Nos. 5, 6 and 7 crucibles.

This wagon is 42 in. wide, 57 in. high to the top of the tool box and its length, exclusive of the handle, is 7 ft. 5 in. A blueprint showing the design and dimensions in more detail than the accompanying sketch can be secured from the Metal and Thermit Corporation.

MACHINE TOOL EXHIBITION IN ENGLAND

London, Eng.

The machine tool industry of Great Britain not having the opportunity of exhibiting its products at the meetings of any of the engineering societies, in the manner so common in the United States, but at the same time realizing the advantages of putting on show its products, arranged a three weeks' exhibition, during September, of machine tools at "Olympia," a large exhibition hall in London. The exhibition was handled by the Machine Tool Trades Association. It was a well organized affair and full of interest to the engineering industry in Great Britain. Many of the machine tools exhibited gave actual demonstrations of the work they were designed to perform. The exhibition was open from 10.30 in the morning to 9.30 in the evening and an admission fee of two shillings (40 cents) was charged, but a large number of complimentary tickets were distributed to the trade by the exhibitors.

In connection with the exhibition two conferences were held during the last week. On Tuesday, September 21, there was a conference of employers and employed which was arranged by the Industrial League and Council during which the following subjects were discussed: "Unemployment and Production" and "High Prices and World Competition." On Wednesday, September 22, there was an Industrial "Safety First" conference held under the auspices of the Home Office and the British Industrial "Safety First" Association. On this day the morning session was presided over by the Rt. Hon. Edward Shortt, Secretary of State, Home Department, and the following papers were read: "Safety First and its Application to Industry," "The Safeguarding of Machinery" and "First Aid in the Factory." The afternoon session was presided over by Lord Leverhulme, president of the association, and papers were read on "Health, Hygiene and Safety First," "Why and How We Introduced Safety First Methods," "Notes on Safety First for a Large Factory," "Safety First in a Steel Works," "Observations on a Works Safety First Scheme," "Safety First as Applied at Port Sunlight" and "Lighting as an Aid to Safety."

A very complete catalog of some 420 pages was sold in the hall for one shilling (20 cents.) This catalog contained a complete list of all the products shown by the various exhibitors and a good deal of space was given to advertising these products.

The exhibition hall consists of a ground floor, on which was exhibited the heavy machinery, and a gallery on which were exhibited the lighter products. There were in all 167 exhibition booths. The exhibition included machine tools manufactured in Great Britain and a large number of machine tools of other countries which are handled by the machine tool agents in Great Britain. Of these American tools form by far the greatest majority. As a matter of fact the American tools were a relatively large proportion of all the tools exhibited. There were a few Swiss, French, Danish and Swedish tools shown, but no German tools.

Among the American machine tool builders represented may be mentioned the following:

Baush Machine Tool Company
Becker Milling Machine Company
Brown & Sharpe Manufacturing Company
Bullard Machine Tool Company
Carborundum Company
Chicago Pneumatic Tool Company
Cleveland Twist Drill Company
Colburn Machine Tool Company
De Vilbiss Mfg. Company
Dixon Crucible Company, Joseph
Foster Machine Company
Geometric Tool Company
Gisholt Machine Company
Gould & Eberhardt
Greaves-Klusman Tool Company
Heald Machine Company
Ingersoll Milling Company
Jacobs Mfg. Company
Kearney & Trecker Company
Landis Machine Company
Landis Tool Company
Lapointe Machine Tool Company
Le Blond Machine Tool Co., The R. K.
National Acme Co., The
Newton Machine Tool Works, Inc.
Norton Company
Potter & Johnston Machine Company
Quickwork Company
Reed-Prentice Company
Starrett Company, The L. S.
Warner & Swasey Company

The number of visitors at the exhibition demonstrated the interest which the English engineering industries displayed in it. It was very apparent that the visitors attended from no idle curiosity but for the purpose of learning how improved machine tools can be used advantageously in their work.

Steel Treaters Meet at Philadelphia

Two Steel Treating Societies Amalgamate and Hold Second Annual Convention and Exhibition

ONE of the most important steps toward a more widespread knowledge of the correct heat treatment of steel was taken at the Commercial Museum, Philadelphia, Pa., September 14, when the American Steel Treaters' Society and the Steel Treating Research Society united in a new organization known as the American Society for Steel Treating. The occasion for the union of the two societies was the second annual steel treaters' convention, lasting five days from September 14 to 18 inclusive. More than 250 members attended the opening session, which was presided over by Lt.-Col. A. E. White, chairman of the Amalgamation Committee. The total attendance for the week was 12,000

The convention was welcomed to Philadelphia by E. J. Cattell, city statistician, on behalf of Mayor Moore, who was unable to be present. Lt. Col. White responded to Mr. Cattell. Eight technical sessions were held and many important papers covering practically all phases of steel treating were read or presented by title. Some of these papers are of especial interest to railway shop men and will be abstracted in this and subsequent issues of the *Railway Mechanical Engineer*.

The exhibition of all kinds of heat treating equipment and many heat treated products including forgings, die blocks, castings, tool steel, etc., was exceptionally complete and interesting. Nearly 100 manufacturers were represented on the floor of the exhibition hall and much of the equipment

Lieut.-Col. A. E. White
President

T. E. Barker
First Vice-President

T. D. Lynch
Second Vice-President

W. H. Eisenman
Secretary

W. G. Bidle
Treasurer

was shown in actual operation. Particular comment was made on the display of stainless steel cutlery and tools and the statement was made that American manufacturers may well hope to equal, if not surpass, the famous Sheffield steels manufactured in England.

At the conclusion of the technical sessions, numerous inspection trips to industrial plants and other points of interest were made. The annual banquet and entertainment was held Thursday night, September 16, in the grand ballroom of the Bellevue-Stratford. Following the banquet the members and guests were addressed by Dr. Albert Sauveur, professor of metallurgy, Harvard University, Dr. Joseph W. Richards, secretary of the American Electro-Chemical Society and Samuel M. Vauclain, president of the Baldwin Locomotive Works, Philadelphia.

A PROCESS FOR THE MANUFACTURE OF HELICAL SPRINGS FOR HEAVY DUTY

BY T. D. LYNCH

Research Engineer, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Helical springs subjected to an unusually severe duty are shown in Fig. 1. They transmit the driving power of the motor to the wheels of a locomotive through gears and a set of cushion springs, the arrangement being such as to permit free vertical and lateral wheel play. In this application the stresses are tension, compression, torsion and shear, separately or in combination, and these stresses are augmented from time to time by shock, producing a condition that makes

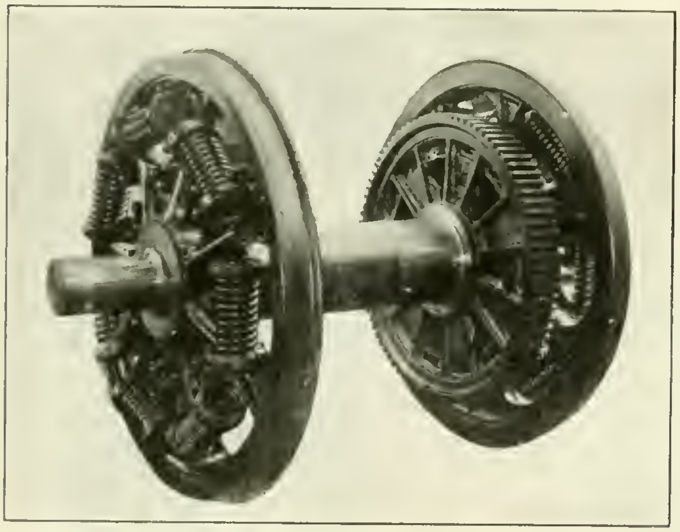


Fig 1—Driving Arrangements on Electric Locomotive Wheel

necessary a material of high elastic strength, and, at the same time, a large degree of toughness. The common practice of spring making, using carbon steel, did not produce a sufficiently reliable spring and it was found necessary to use an alloy steel specifying not only its analysis but the entire process of manufacture and testing.

Manufacture of the Steel

The steel shall be made by the crucible or electric furnace process and have the following chemical analysis:

Carbon	.50-.60 per cent	Sulphur	Not over .04 per cent
Manganese	.60-.80 per cent	Silicon	1.90-2.20 per cent
Phosphorus	Not over .04 per cent		

The ingots shall be not less than 9 in. square at the large end and 8 in. square at smaller end, so poured and the molds so coated as to give a smooth surface to the ingot. Each ingot, when cold, shall be carefully inspected and any blemishes chipped or ground out, leaving a surface free from laps or seams after rolling. The ingots shall be slowly and carefully heated to approximately 1,100 deg. C., rolled or forged to squares of approximately 3 in. by 3 in. and sheared into suitable billet lengths for final rolling. Excessive reduction will not be permitted. Sufficient discard shall be made so that no sign of piping or segregation can be found when careful inspection is made, especially of the top cut.

The billets shall be allowed to become cold and a very careful inspection made for surface defects and any slight blemishes ground out, leaving a smooth, even surface, no ragged corners or slivers being permitted. The billets shall then be heated to approximately 1,100 deg. C. and rolled to finish size, great care being taken to avoid excessive reduction at any one pass. The bars shall be sheared to length and carefully inspected for piping, segregation and surface defects. Each bar shall be straight, free from surface cracks, scratches, seams, folds and indentations and shall be true to section. The diameter of the bar shall not vary more than two and one-half per cent from that specified. All bars shall be tied in bundles and a metal tag securely attached to each bundle. This tag shall have stamped on it the requisition number, heat number, size of rod and manufacturer's identification mark. When bundles are opened, great care must be exercised not to nick or in any way injure the bars. A nick or scratch in a bar, however small, cannot be permitted.

Coiling of Springs

The bars shall be heated slowly to a uniform temperature of approximately 925 deg. C. and immediately coiled over a mandrel preheated to at least 100 deg. C. The mandrel shall not be water cooled, nor shall any water be allowed to touch the spring while hot. Notching for length shall be done at a dull red heat and in such a manner as not to cut, scratch or otherwise injure the surface at any other point on the spring. The springs after notching shall be allowed to cool slowly and uniformly in such a manner as to prevent local chilling, which may cause surface stresses or cracks to form.

The springs shall be slowly and uniformly preheated to approximately 700 deg. C., transferred to a furnace held at a quenching temperature of 900 deg. C. and uniformly heated as near as possible to this temperature and quenched in oil. The quenched spring shall be drawn in a salt bath at approximately 455 deg. C. to relieve quenching stresses. The drawn springs shall be cleaned from the adhering salt by a hot soda wash, followed by an oil or lime dip to protect them from corrosion.

Physical Properties and Tests

The properties specified below shall be determined in the order given and the spring shall not be rapped or otherwise disturbed during the test.

(a) The solid height is the perpendicular distance between the plates of the testing machine when the spring is compressed solid with a test load at least 125 per cent of that necessary to bring all the coils in contact. The solid height shall not vary more than 1.5 per cent from that specified.

(b) The free height is the height of the spring when the load specified in (a) has been released, and is determined by placing a straight-edge across the top of the spring and measuring the perpendicular distance from the plate on which the spring stands to the straight edge, at the approximate center of the spring. The free height shall not vary more than 1.5 per cent from that specified.

(c) The loaded height is the distance between the plates of the testing machine when the specified working load is applied. The loaded height shall not vary more than 1.5 per cent over, nor more than .70 per cent under, that specified.

(d) The permanent set is the difference, if any, between

the free height and the height (measured at the same point and in a similar manner) after the spring has been compressed solid three times in rapid succession with the test load specified in (a). The permanent set shall not exceed 4 per cent of the free height.

(e) The Brinell hardness number shall not be less than 375 nor more than 450. This test shall be made on the coupon resulting from notching to length and broken off after the spring has been heat treated.

(f) The grain structure of the finished spring should be troostitic or troosto-sorbitic.

Specifications as to dimensions, packing and inspection also were included in this paper, which was intended to emphasize the great importance of a better knowledge of complete spring manufacture and bring together on common terms the designing engineer, the steel maker and the spring maker.

THE FIELD FOR HEAT TREATED LOCOMOTIVE FORGINGS

BY J. C. MARSH
Metallurgist, *Railway Mechanical Engineer*
AND C. B. BECK
Associate Editor, *Railway Mechanical Engineer*

There is hardly a forged part entering into the construction of the locomotive which is not a fit subject for heat treatment in some form, and there are none of the operations covered by the general term "heat treatment" which have not already been employed to some extent either in the manufacture or maintenance of these parts. In considering the field for heat treatment of locomotive forgings a knowledge of the conditions of service to which these parts are subjected is quite necessary. The important parts to which the present discussion will be limited are the reciprocating parts, which include piston heads, piston rods, cross head pins and main rods, and connecting rods, crank pins, axles and valve motion parts.

In varying degree these parts are all subjected to shocks and constant repetitions of alternating stresses. In a table included in the progress report* of the Committee on Fatigue Phenomena in Metals, which is acting under the joint auspices of the Engineering Foundation and the Division of Engineering of the National Research Counsel, is given the approximate service required of various structural and machine parts subjected to repeated stresses. The approximate number of repetitions of stress in the life time of these parts varies from 2,000,000 for the members of railroad bridges to 15,000,000,000 for steam turbine shafts. Next to the highest figure shown is 1,000,000,000 for steam engine piston rods, connecting rods and crank shafts. Considering the life of the average locomotive, it is probable that the same parts of the locomotive should be able to withstand from 300,000,000 to 400,000,000 stress repetitions within the time they are in service. The life of airplane engine crank shafts is given as 18,000,000 stress repetitions and that of automobile engine crank shafts as 120,000,000. These figures are only approximate but they serve to show the comparatively severe limitations which are placed on refinements of the design of locomotive parts, in order that they may successfully withstand the severe shocks and heavy repeated loads to which they are subjected during a life time which is long as compared to that expected from similar parts in automobile or aeroplane engines.

Limitations Modified by Heat Treating

It is these limitations to refinements of design which heat treatment (the term now being used in its restricted sense of quenching and drawing) has offered some promise of modifying. The greatest need for such modification is in connection with the reciprocating parts. Here the need for refinement permitting the use of lighter parts is measured not by the possible reduction in weight of the parts themselves but by the reduction of the destructive effect of the dynamic augment, that is, the vertically unbalanced centrifugal force produced by the excessive counter balance which must be placed in the driving wheels to take care of the horizontal effect of the reciprocating parts, which multiplies the effect of the weight involved by 36 to 40 times at the maximum speeds of the locomotive. Thus every pound by which the weight of reciprocating parts is reduced permits the addition of many times that amount of effective weight in some other part of the locomotive without any increase in destructive effect of the locomotive on track and bridges. The need, therefore, is for a material which may be subjected to higher working stresses alternating from a maximum load in tension to a maximum in compression (under the conditions of column loading). But owing to the large amount of clearance and wear which are permitted in locomotive bearings as compared with the bearings of other machines, each repetition of stress subjects the parts to severe shocks. No increase in working stress can, therefore, be permitted which decreases the ability of the material to withstand several hundred million of these shocks without failure.

The sizes of driving axles on modern locomotives, particularly those of the 2-10-2, or Santa Fe type, have increased to such proportions that they present a real problem in locomotive design. Sizes have increased until journals 12 in. and 13 in. in diameter are not uncommon and the difficulties from friction and wear, owing to the high peripheral speed of these large bearings, present a serious problem. Here, it is evident that the importance of being able to increase working stresses above those commonly used in the design of these parts is much greater than can be measured by the saving in weight to be effected on the locomotive as a whole. These axles in addition to the load on the bearings due to the weight of the machine, are subjected to constantly repeated combined torsion and bending stresses, each repetition involving shocks, increasing in severity as the bearings wear. The axles are also subjected to shocks from the lateral motion of the engine, acting against the rail through the wheel flanges, and from rail joints, frogs and crossings.

While the same need does not exist for reduction in the weights of crank pins as has been pointed out in the case of reciprocating parts and axles, there is no doubt but that full advantage would be taken in the design of these parts of any material offering the possibility of a higher working stress without a sacrifice of reliability. This statement probably applies with equal force to valve motion parts. The whole problem, therefore, in considering the possibilities for increasing working stresses in locomotive forged parts may be summarized as that of maintaining unimpaired the reliability of these parts to withstand fatigue stresses. Reliability—freedom from failures under sudden and severe shocks—is the first requirement for locomotive forgings; long life, the ability to resist fatigue, is the second requirement, and the third—a high working stress—must not be obtained at the sacrifice of either of the other two.

Factors of Safety

A general idea of the factors of safety considered necessary in the design of these parts may be obtained from the following table which shows the working stresses usually used in the calculations of sizes of critical sections:

Part	Working stress, lb. per sq. in.
Crank pins	17,000
Axles	23,000
Main rod stubs and straps	5,000-8,000
Piston rods	10,000

These stresses are based on carbon steel with a carbon content ranging between .38 per cent to .52 per cent with the

*See *Mechanical Engineering* for September, 1919, page 731.

following minimum physical requirements for the annealed forgings:

Tensile strength, lb. per sq. in.	80,000
Yield point	.5 tens. str.
Elongation in 2 in., per cent	18-20

In locomotive parts, as in those of all machines, the yield point or elastic limit is of considerable importance. An increase in elastic limit is always a tempting factor, in that it offers a possible reduction of cross sectional area, and a corresponding reduction in the weight of the part. Ductility, however, is the counter balance. Endurance to alternating or vibratory stresses is presumably dependent on the difference between the yield point and the ultimate load, although it is by no means an infalliable criterion. The railway mechanical engineer desires a high yield point and knows he must have a goodly percentage of elongation.

There is little difficulty in securing a considerable range of static physical characteristics by the application of heat treatment. A carbon steel with a carbon content near the lower limit of the above specifications may have its yield point raised nearly to the tensile strength of the annealed material by quenching and drawing, without reducing the elongation lower than the minimum specified. The range between the elastic limit and the ultimate load, however, is reduced, and in the case of carbon steel, grave doubts exist in the minds of some engineers as to the safety of taking advantage of these improved static properties of the material for any increase in allowable working stresses.

Another factor must be given serious consideration in connection with the employment of heat treating processes on locomotive forgings. The average conditions surrounding the maintenance of railroad motive power is such that any part, the normal working physical properties of which cannot be safely restored by the simple process of annealing, following possible repairs in the blacksmith shop, or which requires special care in machining to prevent the possibility for the development of dangerous local stresses, such as might result from rough lathe work on certain parts, has a restricted opportunity to show what it is worth. There is also an element of risk in its use, which violates the first requirement for locomotive material.

Alloy Steels

In view of the hesitancy to place full dependence on the raised yield point which may be obtained with carbon steel by suitable heat treatment, it seems evident that any extensive development toward possible increased working stresses must be largely with the alloyed steels.

With the carbon comparatively low, that is around 0.30 per cent, and the strength of the steel built up with such alloying elements as nickel, chromium, uranium, boron, copper and molybdenum, the results of heat treatment become more uniform, and an increase in ultimate strength and yield point can be obtained with less sacrifice of ductility and endurance. A slight gain in yield point may be obtained by quenching the steel and then drawing to a temperature nearly up to the quenching temperature. Some alloy steels can be heated to a point just below the critical temperature, quenched in oil and then drawn to a temperature about 400 deg. F., lower than the critical temperature, giving a yield point midway between those of the same steel in the annealed and the quenched states, with a percentage of elongation as high as the annealed steel or higher. Such steels, so heat treated, show a resistance to fatigue nearly equal to that of the annealed steel.

Other alloys have been developed which, when subjected to the simple process of annealing, produce a decided increase in ultimate load and elastic limit as compared with carbon steels of the same ductibility. Some of the vanadium steels are in this class. Such a steel having a carbon content of about .27 per cent, vanadium .17 per cent and chromium 1.0 per cent, annealed at 1,570 deg. F., develops an ultimate tensile strength of 96,000 lb., an elastic limit of 63,000 lb., with an elongation of 33 per cent in 2 in. and a reduction of area of 61 per cent. Plain carbon-vanadium steels having 20 points carbon, and .27 points vanadium, annealed at 1,475 deg. F., develop a tensile strength of 81,000 lb. and an elastic limit of 63,000 lb. with an elongation of 29.5 per cent and a reduction of area of 59.4 per cent.

Another alloy steel has recently been developed which possesses similar characteristics. This steel is a simple alloy of uranium and carbon. Tests of such a steel having a content of .12 per cent carbon and .15 per cent uranium, have shown a tensile strength of 52,000 lb., an elastic limit of 33,300 lb., a 40.5 per cent elongation and a reduction of area of 70.5 per cent after annealing. With a higher carbon content of .54 per cent and .29 per cent uranium, this steel developed a tensile strength of 101,690 lb., an elastic limit of 58,960 lb., a 23 per cent alongation and a reduction of area of 45.5 per cent.

There are a large number of steels which produce excellent results when subjected to the quenching and drawing process. Among these it may be well to mention the molybdenum steels, because of the comparatively wide temperature range within which they may be heated without detriment to their physical properties. Typical results of tests on 1¾-in. bars, heat treated full size, and machined to .505 in. in diameter, showed a hardening range from 1,400 deg. F., to 1,600 deg. F.; these test bars were quenched in water from 1,540 deg. F. The analysis is as follows:

Carbon	.26 per cent
Mg.	.60 per cent
Si.	.10 per cent
Cr.	.75 per cent
Ni.	1.96 per cent
Mo.	.56 per cent
Tensile strength	149,000 lb.
Elastic limit	120,000 lb.
Elongation in 2 in.	25 per cent
Reduction of area	68 per cent

Except for the longer life expected of the locomotive, the design of the automobile and motor truck involves much the same problems as the design of the working parts of the locomotive. The stresses to which automobile parts are subjected are quite as varying as those of locomotives. Impact stresses sustained by automobile axles are far greater in proportion to the cross section area of the axle than those to which locomotive axles are subjected. The automobile and truck axle has to resist alternating, vibratory, transverse and shock stresses. These axles are usually heat treated and their yield points are higher than those of locomotive axles per square inch of cross section area. Their dead load is comparable with that on the locomotive and their design is a factor against them as compared with those of a locomotive. Their percentage of failures is certainly not greater. The automotive field has about solved its problem by the use of heat treated alloy steels and the railways have not solved theirs at all.

Conclusions

The greatest obstacle to a rapid development in the use of heat treated locomotive parts is probably the conditions under which locomotives are maintained, together with the much greater importance of maintenance as a factor controlling the original construction in the case of the locomotive than that of the automobile. Railroad shops are seldom provided with facilities suitable for working materials which require the complicated heat treatment of pieces of large size, and practically all of the forged parts under consideration are passed through the blacksmith shop, either in the course of maintenance, or to be reclaimed for other use, in sufficient number, to make such equipment quite essential if results on a large scale are to be obtained.

The problem is by no means hopeless, but it seems evident that for the immediate future at least, the greatest possi-

bilities for development lie with alloy steels of the simplest composition, in which the greatest reliability, longest life and highest tensile strength can be developed by a simple heat treating process, not requiring too great a degree of precision.

As the effect of heat treatment on fatigue properties becomes less a matter of speculation, and the railroad world becomes better acquainted with the physical effects of the heat treating process the designer will undoubtedly be less loath to take advantage of the wider range of possibilities offered by the more complicated heat treating processes.

THE HARDENING OF HIGH SPEED STEEL

BY A. H. D'ARCAMBAL

Chief Metallurgist, Pratt & Whitney Company, Hartford, Conn.

The experiments referred to below were run primarily to determine the effects of various hardening methods on the hardness, microstructure and cutting efficiency of high speed steel. The best known brands of high speed steel made in this country and abroad were selected for these tests, the analysis of the steels being shown in Table 1. As can be seen from this table eight of the brands were made by the crucible process, the other four being melted in the electric furnace. The majority of the analyses are of the eighteen, one, four type. Steels numbered seven and twelve were both supposed to be of the high vanadium lower tungsten analysis but the vanadium in number seven steel is much lower than the desired percentage. Bar number five is an analysis quite new to this country but better known abroad. Steel number six was selected to determine if cobalt present in an eighteen, one, four type of steel added to its cutting efficiency. The forged blanks, assigned number fourteen, were made from bar number fifteen. Steels number five, eight and ten were made abroad. As it was decided to use four-inch cutters in this test, the bars were ordered four and one-fourth inches round. The Brinell hardness ran from two hundred and seventeen to two hundred and eighty-six, the only one giving trouble in machining being number five bar, but the trouble was not severe enough to make it necessary to reanneal this steel.

TABLE I—ANALYSES OF HIGH SPEED STEELS USED IN TEST

No.	Carbon	Mang.	Phos.	Sulp.	Sil.	Chrom.	Van.	Tungsten	Cobalt	Molyb.	Brinell hard	Method of manufacture
*1C	.70	.18	.017	.025	.13	3.53	.68	17.56	...	...	286	Cruc. melted
*2C	.67	.30	.016	.009	.11	3.66	.95	17.39	...	...	241	Cruc. melted
3	.65	.16	.022	.025	.24	4.70	1.02	18.45	...	...	228	Elec. fce. melted
*4	.64	.24	.017	.025	.16	3.33	1.01	18.44	...	...	228	Cruc melted
5C	.70	.18	.026	.024	.41	4.43	...	...	5.25	4.90	255	Cruc. melted
*6C	.68	.30	.014	.010	.22	3.68	.97	17.51	3.27	...	286	Elec. fce. melted
7	.70	.21	.020	.025	.31	4.45	1.18	12.65	...	...	241	Elec. fce. melted
8	.67	.14	.020	.020	.23	3.37	.97	19.05	...	...	217	Cruc. melted
10C	.62	.22	.017	.009	.14	4.14	.26	17.84	...	...	269	Elec. fce. melted
11	.63	.34	.024	.022	.15	3.89	.85	18.60	...	...	241	Cruc. melted
*12C	.80	.25	.024	.014	.14	3.57	1.75	14.70	...	...	228	Cruc. melted
14	.62	.34	.014	.023	.09	3.74	.55	17.87	...	...	217	Cruc. blank fgd.
*15	.62	.34	.014	.023	.09	3.74	.55	17.87	...	...	217	Cruc. melted

*Indicates that bars are rough turned.

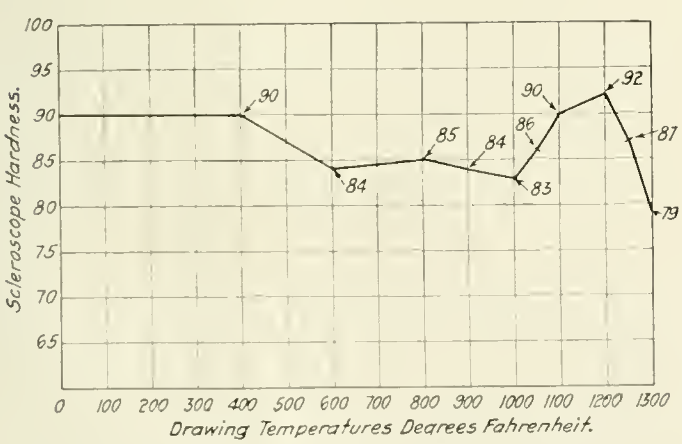


Fig. 1—Scleroscope Curve, Steel No. 1, Heated to 2,300 Deg. F, in Open Fire and Quenched Into Oil at 100 Deg. F.; Drawn at Temperatures Indicated.

Small discs were cut from some of the bars, thirteen of these being heated in the open fire furnace to 2,300 deg. F. and quenched into oil, thirteen heated in barium chloride at 2,100 deg. F. and oil quenched, and thirteen heated in a charcoal pack to about 2,050 deg. F. and oil quenched. These were then given various drawing temperatures up to 1,300 deg. F. and the scleroscope hardness taken, using a type D scleroscope (Dial recording type). The results plotted on six charts one of which is shown in Fig. 1 give the following information:

Conclusions from Scleroscope Curves

1. That the majority of brands of high speed steel when given a high quenching temperature (about 2,300 deg. F.) are just as hard or slightly harder after being drawn to 1,100-1,150 deg. F. as when quenched.

2. That 600-1,000 deg. F. is the softening range for hardened high speed steel.

3. When high speed steel is quenched from a lower temperature (2,000-2,100 deg. F.) almost the same initial scleroscope hardness is obtained as when quenched from a higher temperature, and the same characteristic curve is obtained on drawing. The lower the quenching temperature, however, the lower the temperature at which the rehardening occurs on drawing and the greater the falling off in hardness after this point is passed.

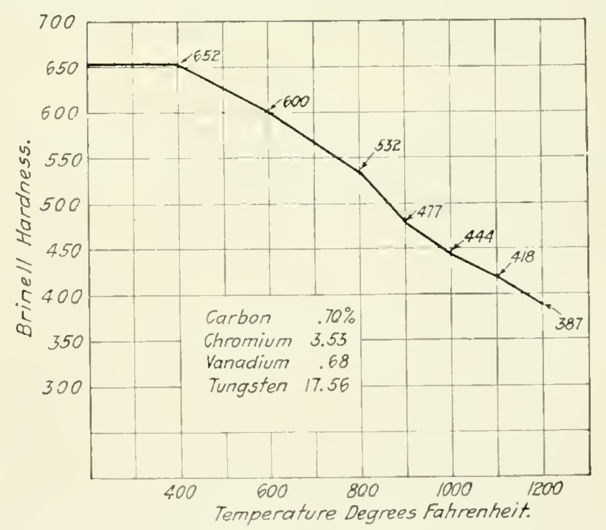


Fig. 2—Brinell Curve, Steel No. 1, Heated to 2,350 Deg. F. In Open Fire and Quenched Into Oil at 100 Deg. F., Brinelled at Temperatures Shown.

Samples which had been quenched from 2,300 deg. F. and drawn to 1,100-1,150 deg. F. were redrawn to 600 deg. F. but did not change their scleroscope hardness. This shows that the scleroscope curve obtained on redrawing a piece of hardened high speed steel which had been drawn to 1,100 deg. F. would be a straight line, instead of showing a softening range from 600-1,000 deg. F. as is obtained on the original drawing of the sample hardened from a high heat.

In order to determine the hardness of hardened high-speed steels at temperatures from 400 deg. F. to 1,200 deg. F. temperature Brinell curves were obtained as follows: five-eighths inch thick discs were cut from the four and one-fourth inch round bars of high speed steel, and these were

cut in two. These discs were then hardened and brinelled cold. The method of hardening one disc is shown in Fig. 2. They were then heated in a small electric muffle furnace, two at a time, the pyrometer placed between the two discs and touching them. The pieces were held at the desired temperature for a sufficient length of time to insure thorough soaking, and then removed from the furnace, placed on a steel block of the same temperature, and rapidly brinelled. A new Brinell ball was used for each Brinell. These impressions were read immediately after brinelling and the discs again placed in the furnace for the next higher temperature. After the Brinell at 1,200 deg. F. was taken, the pieces were quenched and again brinelled. A temperature Brinell curve on a disc of carbon tool steel, properly quenched, was also obtained for comparison. A study of the Brinell curves showed the following:

Conclusions from Brinell Curves

1. The higher the quenching temperature the greater the hardness at temperatures from 600 deg. F. to 1,200 deg. F.
2. The cobalt molydenum steel shows considerably lower temperatures, Brinell reading from 400 deg. F. to 900 deg. F. temperatures than do the tungsten steels.
3. High-speed steel quenched and drawn to 1,100 deg. F. shows a greater Brinell hardness at temperatures from 600 deg. F. to 900 deg. F. than when only drawn to 450 deg. F.
4. The temperature Brinell readings on the high-speed steel quenched from 2,300 deg. F. are all the same with one exception, at 1,100 deg. F.
5. Hardened high-speed steel, while not as high as carbon tool steel as quenched, is almost three times as hard at a lower red heat.

Cutter Tests

It was decided to use heat-treated chrome-nickel steel, similar to that used for crankshafts, connecting rods, etc., in aeroplanes and automobiles for testing these cutters. The one and five-eighths in. by two and one-half in. bars of this steel were all from the same electric furnace heat of steel, and all hardened exactly the same, giving a Brinell hardness of two hundred and sixty-nine to two hundred and seventy-seven. All sides of these bars were rough ground after hardening, removing the scale. Some of these cutters failed at the corners, others showed a uniform wearing down of the cutting edges. Table 11 shows the results of these tests and all figures given are the average of two cutters, making the final average in each case that of four cutters.

The cutter used was of the coarse tooth side milling type, 4 in. by 5/8 in. by 1 in. hole. The material cut was slabs 16 in. by 2½ in. by 1⅝ in. with the following analysis: carbon, .46 per cent; manganese, .60 per cent; chromium, 1.16 per cent. The physical tests (standard .505 test piece) showed: elastic limit, 112,000 lb. per square in.; tensile strength, 126,000 lb. per square in.; elongation 20 per cent; reduction of area, 54 per cent; Brinell hardness, 269. The constants were: speed, 130 ft. per min.; feed, 3 11/16 in. per min.; depth of cut, ⅛ in., and coolant, oil.

Steel number twelve, the high vanadium lower tungsten material, showed the highest cutting efficiency, the cobalt steel coming second. In every case, cutters given the 1,100 deg. F. draw showed a much greater cutting efficiency than with the 450 deg. F. draw. Cutters made from number five steel were given a quenching temperature higher than that recommended by the manufacturer, but it was decided to harden all of these cutters in exactly the same way. Cutters made from forged discs showed about twenty-five per cent greater efficiency than those machined from the same bar.

Cutters drawn to 800 deg. F. which is in the softening range, showed less efficiency than when drawn to 450 deg. F. Cutters quenched from 2,300 deg. F. into nitre at 1,100 deg. F. held there about four minutes, and oil quenched show about twice as much work as when quenched into oil and drawn to 450 deg. F., and a little more than half as much work as when given the 1,100 deg. F. draw. As nitre at 1,100 deg. F. will attack high-speed steel quenched from a high temperature, a lead bath is recommended.

TABLE 11—RESULTS OF CUTTER TESTS

No. of steel	Heat treatment of steel	Inches of metal cut	Remarks
12	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	132	
12	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	214	
12	Average	173	
6	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	107	
6	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	183	
6	Average	145	
10	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	67	
10	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	216	
10	Average	142	
7	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	88	
7	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	155	
7	Average	122	
2	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	59	
2	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	182	
2	Average	121	
1	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	60	
1	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	140	
1	Average	100	
5	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	12	
5	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	65	
5	Average	39	
14	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	88	Cutters made from forged blanks using No. 15 bar.
14	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	168	
14	Average	128	
15	2,300 deg. F. Open fire, oil quenched, 450 deg. F. draw	48	
15	2,300 deg. F. Open fire, oil quenched, 1,100 deg. F. draw	155	
15	Average	102	
2	2,300 deg. F. Open fire, oil quenched, 800 deg. F. draw, average	54	
2	2,300 deg. F. Open fire, oil quenched into nitre at 1,100 deg. F. Not drawn. Average	111	

Precautions in Hardening High-Speed Tools

1. The tools should be thoroughly preheated, the use of two preheated furnaces being recommended, one maintained at a temperature of from 1,000 to 1,100 deg. F. and the other at a temperature from 1,500 to 1,700 deg. F.
2. The tools should be kept in the superheat only long enough for the material to come to the proper temperature. Soaking at high temperatures ruins the steel.
3. A careful selection of the quenching oil should be made as too rapid a quenching oil will cause cracks.
4. When drawing hardened high-speed steel to around 1,100 deg. F., the material should be brought up to the desired temperature with the bath, and never placed into the bath at 1,100 deg. F., as this will also produce cracks. The material should be held from ten to thirty minutes at the drawing temperature and air cooled or oil quenched.

THE FUTURE FUEL FOR THE TREATMENT OF STEEL

BY H. O. LOEBELL
Industrial Heating Dept., H. L. Doherty & Company, New York

This paper deals with the introduction, utilization and application of a fuel which will permanently solve the heating problem of industry. Important fuels of today are fuel oil, pulverized coal, and industrial manufactured gas. Fuel oil is a desirable fuel, but because of insufficient supply cannot be considered as the future fuel of our industry. Some

years ago fuel oil was selling at 2½ cents per gal. and could be obtained in any desired quantity. Today it is selling at 12 cents to 15 cents per gal. and in many cases cannot be obtained at any price. This condition brings out the importance of considering the permanency of a fuel. Powdered coal is desirable in many cases but is only an intermediate development in the final solution of the problem. Ultimately our enormous coal resources will have to be treated in such a fashion that all the valuable materials from a ton of raw bituminous coal will be obtained.

Today, it is an established fact that the most flexible and efficient heating medium is a gaseous fuel. Bituminous coal resources are practically inexhaustible and therefore afford a raw material for the production of a fuel which will be permanent. From this coal we can make a gas which is very efficient and desirable and at the same time obtain all the valuable by-products that are in the coal. Such a fuel besides being permanent will never be prohibitive in price, as our methods of gas production, distribution, and utilization are always becoming more efficient and therefore the price of our gaseous fuel will have a tendency to decrease.

Advantages of Gas Furnaces

A flexible furnace design is one of the advantages in using gaseous fuel; also there are no ashes to bother with and no storage space required for the fuel. With a gaseous fuel, the most efficient combustion is obtained with the least amount of excess air. Also the temperature of a gas furnace is easily controlled and held within 10 to 15 deg. F.

If the merit of an industrial gas is judged by its B. T. U. value per cu. ft., manufactured coal gas of a 626 B. T. U. value would be the best, blue water gas with a B. T. U. of 300 second, and producer gas third. This, however, is not true. When a gas is burned, the heat developed is immediately utilized to heat the products of combustion of the burned gases. The burned gases give up their heat to the furnace walls and materials in the furnace, therefore the true source of the heat is the heat in a unit volume of the products of combustion. Also the flame temperature is directly proportional to the heat units in a cu. ft. of the burned gases. The more B. T. U.'s per cu. ft. of the products of combustion, the higher the flame temperature. This shows that not only are more heat units available, but there is a greater temperature differential between the flame and furnace material, and therefore a greater rate of heat transfer from the gas flame to the material in the furnace. Calculations based on this reasoning show that per cu. ft. of burned gas, blue water gas has both more heat content and greater heat intensity than any other industrial gas. This means greater heat transfer, greater production and higher efficiency.

The fact that a large number of producer gas plants are in existence is no argument against the use of blue water gas or any gas made from coal where all by-products are recovered. The producer gas plant is a part of the industrial institution of the past and only cheap and abundant fuel is justification for its use. One advantage of a gas producer is that a very wide range of fuels can be gasified. In fact, almost any kind of carbonaceous material can be converted into producer gas if it does not carry too much water or is not too greatly diluted with non-combustible material. The gas formed, however, may be difficult and uneconomical to use. Although producer gas is the cheapest gas which can be made per B. T. U. at the present time, its dilution with inert gas and its chemical characteristics greatly diminish its attractiveness as an industrial fuel.

Results of Furnace Tests

In order to show the advantages of a gaseous fuel and particularly a gas with a high flame temperature such as blue water gas, the results of testing several installations, made during the past few years, may be cited. Under the best conditions of oil utilization it was found that 5½ gallons of 142,000 B. T. U. oil can be replaced by 1,000 cu. ft. of a 600 B. T. U. manufactured gas. Under conditions where oil is used with efficiency, 14 gallons of 142,000 B.T.U. per gallon oil has been replaced by 1,000 ft. of 600 B. T. U. manufactured gas. Using coke and manufactured gas, a pound of coke has been replaced by 14 ft. of coke oven gas. At a large automobile plant working on high temperature forgings, 10 B. T. U. blue water gas has been substituted for 11 B. T. U. coke oven gas or 15 B. T. U. fuel oil. Thus, the possible efficiency of utilization of a fuel is directly proportional to its flame temperature and this fact coupled with actual comparative operating results proves conclusively that the most efficient fuel is one having a high flame temperature, such as blue water gas.

Another factor of essential importance in the heat treatment of steel is the formation of the scale of oxidation of the metal. Flue gases of any fuel contain varying amounts of water vapor, carbon dioxide, carbon monoxide, and nitrogen. When the fuel is burned with an excess of air, flue gases contain an appreciable amount of oxygen. This oxygen unites with the steel, forming an undesirable oxide or scale. In order to reduce the scale effect to a minimum, it is good practice to burn fuel with a slightly insufficient amount of air so that the flue gases contain a small percentage of carbon monoxide and no oxygen. Under these conditions far better results have been obtained with a high flame temperature gaseous fuel than with fuel oil. In 200 tests run during a period of several weeks in order to determine the relative values of fuel oil and blue water gas for high temperature forging the results were decidedly in favor of the gas as follows:

1. Increased production for gas over oil....................24.6 per cent
2. Fuel saving of gas over oil on basis of oil..................27.4 per cent
3. The gas furnace showed 36.6 per cent less scaling effect than the oil furnace.
4. The oil furnace had 800 per cent more burned forgings than the gas furnace.
5. Rejections were 50 per cent more on oil furnace forgings than on gas.

Summary

The ideal fuel for the heat treatment of steel must be of the following nature: (1) It must be permanent so that all future developments and furnace installations can be utilized for many years to the greatest possible extent; (2) it must have a high efficiency of utilization. It must be a fuel that will heat the metal with absolute uniformity in the minimum amount of time; (3) the effect of flue gases of the fuel in oxidizing the metal or scale forming must be reduced to a minimum; (4) such a fuel must be suited for our industrial operations and allied with the developments of all fuel resources so that standardized fuel can be produced at large central stations. This would mean enormous production, distribution and utilization; in other words, a cheap fuel. A fuel that approaches all the requirements of the ideal fuel is blue water gas.

RELATIVE ECONOMY OF OIL, GAS, COAL AND ELECTRIC HEATED FURNACES

BY W. H. LYMAN
Gen'l Sup't, Warner Gear Company, Muncie, Ind.
AND S. A. MOULTON
Industrial Furnace Corp., Boston, Mass.

The supply of natural gas has been seriously depleted in sections where it was formerly used and is an unreliable fuel. Owing to strikes of the coal miners and transportation difficulties, the cost of coal has increased greatly, and executives have viewed with alarm the magnitude of their fuel bill. Most serious of all is the fact that the demand for gasolene, kerosene and fuel oil has so far outstripped

the rate of oil production that its price has reached a point almost prohibitive. There is, in fact, a grave question as to the length of time that fuel oil can be secured at any price.

In view of the above serious situation, it is necessary to investigate all sources of heat supply. Table III gives a list of fuels and their respective heat values and cost:

TABLE III—HEATING VALUE AND COST OF FUEL

Fuels	Heating value in B. t. u.	Cost in Central West
Oil	140,000 per gal.	10 cents per gal.
Natural gas	1,100 per cu. ft.	50 cents per 1,000 cu. ft.
City gas	650 per cu. ft.	80 cents per 1,000 cu. ft.
Water gas	300 per cu. ft.	40 cents per 1,000 cu. ft.
Producer gas	170 per cu. ft.	10 cents per 1,000 cu. ft.
Coal	12,000 per lb.	$6 per long ton
Electricity	3,412 per kwh.	1½ cents per kwh.

Temperatures up to 1,800 deg. F., may be obtained with any of the fuels in Table III, but for temperature over 1,800 deg. F., the producer gas and electricity require especially designed furnaces.

The figures shown in Table IV are based on actual tests and while certain assumptions had to be made and more or less empirical methods of deduction used, the results are substantiated by actual experience. In determining installation costs and fixed charges, the cost of installing oil and gas-fired furnaces was assumed to be $100 per sq. ft. of hearth; coal fired furnaces, $150 per sq. ft. of hearth; 100 kw. electric furnaces, $90 per kw.; and 150 kw. electric furnaces, $70 per kw. A charge of 3,000 lb. was assumed to require 8 hours' heat carburizing and 2 hours' heating. The total annual service was 7,200 hours. Fixed charges, including interest, depreciation, taxes, insurance and maintenance were estimated at 15 per cent. Extra operating labor for coal fired furnaces was figured at 60 cents per hour with one man attending to 4 furnaces.

As a result of the tests, the following conclusions may be deduced as to the relative merits of different fuels:

Relative Merits of Fuels

Fuel Oil—
Advantages—
1. Low first cost for installation.
2. Convenient fuel to handle.
3. Simplicity of installation.
Disadvantages—
1. High cost of fuel.
2. Uncertainty of fuel supply.
3. Difficulties of controlling temperature.
4. Damage to product caused by 3.
5. Inefficient combustion.
6. Damage to furnaces from high temperatures when burned efficiently.
7. Fire hazard.
8. Continuous furnaces not practical except for large masses of metal.
9. High labor cost due to 3, 5, 6 and 8.
10. Short life of container boxes as compared with non-oxidizing gas fuel.

City Gas (Especially adapted for high grade high temperature work)—
Advantages—
1. High heat value.
2. Small pipe main due to 1.
3. Can be burned efficiently.
4. Comparatively low temperature of combustion.
5. Accurate temperature control.
6. Uniform quality of product.
7. Minimum damage to product.
8. Simplicity of installation.
9. Low cost of installation.
10. Cleanliness of plant.
11. Low fire risk.
12. Continuous furnace practical.
13. Low maintenance.
14. Low labor cost.
15. Minimum scale.
Disadvantage—
1. High fuel cost.

Coal (Can be used efficiently only for long heat service)—
Advantages—
1. High efficiency.
2. Low fuel cost.
3. Life of container boxes longer than with oil.
4. Total operating cost low.
5. Reliability of fuel supply.
6. Stability of fuel price.
Disadvantages—
1. High initial cost.
2. Repair of fire box due to high combustion temperature.
3. Floor space occupied in coal and ash handling.
4. Difficulty in keeping competent firemen.

Electricity (Limited to temperatures below 2,000 deg. F.)
Advantages—
1. Absolute temperature control.
2. No high combustion temperatures.
3. Long life of furnaces.
4. Simplicity of installation and operation.
5. Elimination of piping mains, pumps or blowers.
6. Automatic continuous equipment.
7. High efficiency.
8. Small floor space occupied.
9. Flexibility.
10. Cleanly plant conditions with consequent high morale.
11. Quality of product.
12. No damage to product.
13. Minimum scale.
Disadvantage—
1. High first cost.

Discussion of Table IV

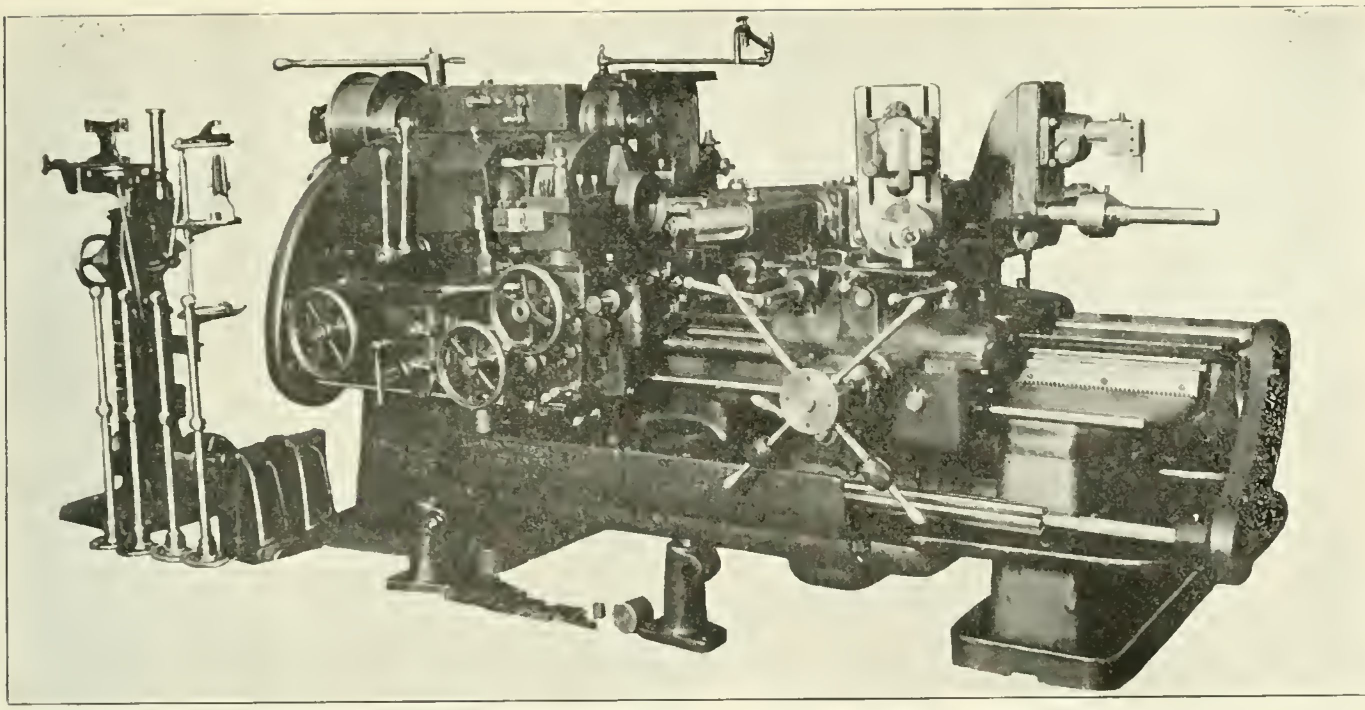
Referring to Table IV, it will be noted that the fuel showing the greatest percentage of saving over oil in both heating and carburizing furnaces was natural gas, this favorable showing being accounted for by low fixed charges and low cost of heat. In carburizing furnaces, the fuel making the next most favorable showing was producer gas, also due to low fixed charges and low cost of heat. The cost of water gas was only slightly less than that for oil. Coal showed a considerable saving over oil due to its low cost and in spite of the fact that there was an extra labor charge. In both heating and carburizing, electric operated furnaces showed a loss as compared with oil furnaces.

Election of Officers

National officers of the American Society for Steel Treating were elected for the year 1920-21 as follows: President, Lt. Col. A. E. White, professor of chemical engineering, University of Michigan, Ann Arbor, Mich.; vice-president for two years, T. E. Barker, production engineer, Miehle Printing Press & Manufacturing Co., Chicago; vice-president for one year, T. D. Lynch, research engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.; secretary for two years, W. H. Eisenman, 208 N. Wabash Ave., Chicago; treasurer for one year, W. S. Bidle, president W. S. Bidle Co., Cleveland, Ohio; directors for two years, H. J. Stagg, asst. manager, Halcomb Steel Co., Syracuse, N. Y., and E. J. Janitzky, metallurgist, Illinois Steel Co., South Chicago; directors for one year, F. P. Fahy, New York, and W. C. Peterson, metallurgist, Packard Motor Co., Detroit.

TABLE IV—COMPARATIVE OPERATING COSTS WITH DIFFERENT FUELS

Class of fuel	Fuel per charge	Fuel cost	Installation cost	Efficiency per cent	Operating costs: Fixed charges	Extra labor	Heat	Total per chg.	Cost per lb.	Saving over oil: Per chg.	Per cent
	2	3	4	5	6	7	8	9	10	11	12
Carburizing—											
Oil	52 gals.	$0.15	$2,400	12.6	$0.40	None	$7.80	$8.20	$.00274	.....	....
Natural gas	4.4 M.	.50	2,400	18.8	.40	None	2.20	2.00	.00087	$6.20	76
City gas	8.3 M.	.80	2,400	17.0	.40	None	6.64	7.04	.00235	1.16	14
Water gas	18.7 M.	.40	2,400	16.4	.40	None	7.48	7.88	.00263	.32	3.9
Producer gas	37.3 M.	.10	2,400	14.5	.40	None	3.73	4.13	.00137	4.07	50
Coal	914 lb.	6.00	3,600	8.4	.60	$1 20	2.45	4.25	.00140	3.95	48
Electricity	500 K.W.H.	.01½	9,000	53	1.50	None	7.50	9.00	.00300	.80 loss	9.7 loss
Heating—											
Oil	30.8 gals.	.15	2,400	21.4	.10	None	4.62	4.72	.00157	.....	....
Natural gas	2.61 M.	.50	2,400	32.0	.10	None	1.30	1.40	.00047	3.32	70.5
City gas	4.9 M.	.80	2,400	28.8	.10	None	3.92	4.02	.00134	.70	14.8
Water gas	11.1 M.	.40	2,400	27.6	.10	None	4.44	4.54	.00151	.18	3.8
Producer gas	22.1 M.	.10	2,400	24.6	.10	None	2.21	2.35	.00078	2.41	51.1
Coal	486 lb	6.00	3,600	15 75	.15	$0.30	1.30	1.75	.00058	3.32	70.3
Electricity	329 K.W.H.	.01½	10,500	81.75	.44	None	4.94	5.38	.00179	.32 loss	6.8 loss



Example of Correct Turret Lathe Practice

A Description of the First Operations Involved in Machining a Small Clutch Gear on a Turret Lathe

BY F. S. HARMER

RAILWAY machine shop operation can be much improved and the output increased by a more general use of turret lathes. Not only are these machines adapted to a wide variety of machine operations, but when properly set up, the amount of work that can be turned out will result in a considerable increase in machine shop output. When machining jobs within fine limits of accuracy,

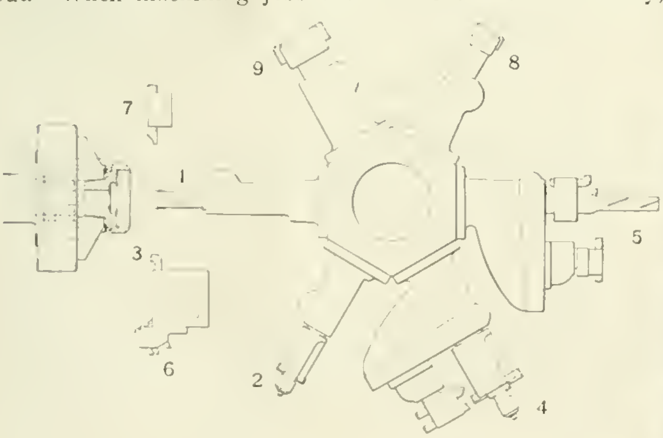
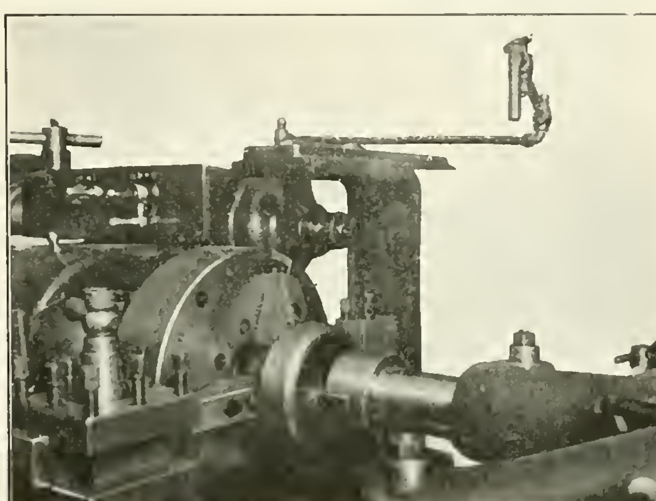


Fig. 1—Outline of Tool Set Up on Combination Turret Lathe

care must be taken in the method of machining to avoid distortion. The combination turret lathe is adaptable in this respect because of the great scope in the lay-out of the tools which makes possible a proper tool set-up to prevent undue strain of relieving in the finishing operations. The clutch gear, illustrated in Fig. 2, is made of a 70-point carbon steel forging and has some heavy counter-boring cuts, the limits in the 6-in. and 85 mm. diameter bores being within .001 in. The face setting on this piece consists of turning the 7¼-in. outside diameter, drilling and boring the larger recesses, facing the same and forming the chamfer. The piece is held in a 15-in. Coventry concentric chuck with special taper jaws for gripping the small diameter and is located with a set screw in each jaw to insure the piece be-



Tool Set Up 9; Finish Reaming 6 In. Diameter

ing chucked in the correct position relative to the stops on the machine.

Referring to Fig. 1, the forging is first drilled through with the inserted bit *1*. Drills of this type are very economical, especially in drilling long holes, as they have no tendency to bind. They consist of a mild steel shank with an inserted high speed steel bit. When breakage occurs or the

bit is ground away so far as to be of little use, the cost of replacement is much less than the cost of a twist drill of the same diameter. The next operation is counter-boring the 85 mm. diameter. This is done with the counter-boring cutter, *2*, which is steadied by a roll on the front of the bar. The cutter used is double ended and removes an equal amount

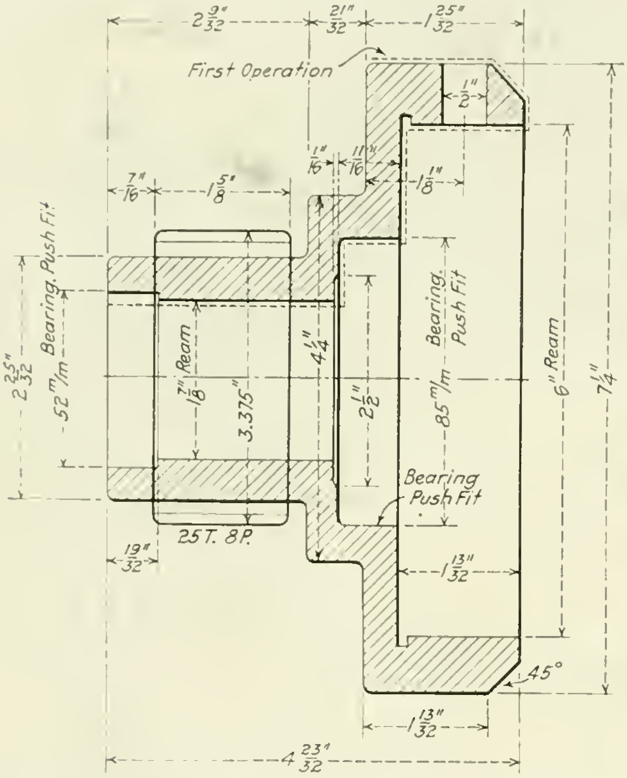
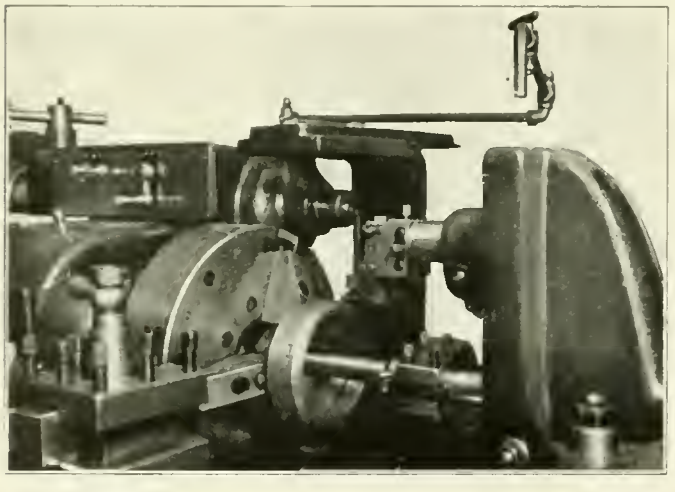


Fig. 2—Dotted Lines Indicate First Operations on Clutch Gear

of metal on either side, thus tending to steady the cutting action of the tool.

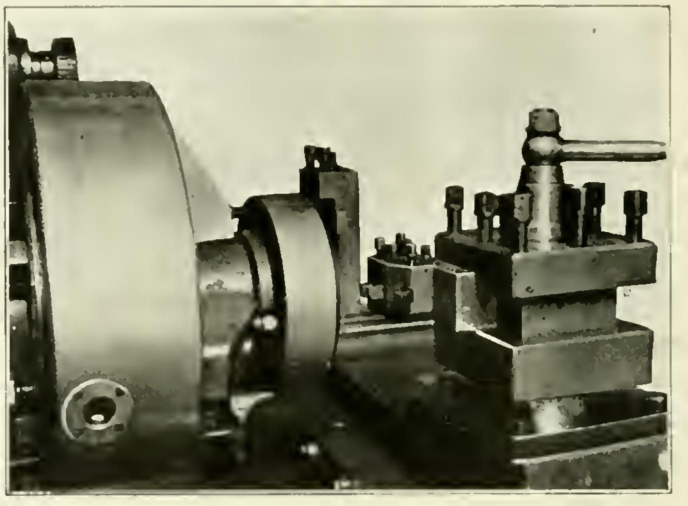
The next operation *4*, consists of counter-boring the 6-in. diameter, rough turning the 7¼-in. external diameter and rough forming the chamfer. In this operation, the counter-



Tool Set Up 5; Finish Boring and Turning Operations

boring cutter alone is removing 1 5/16-in. of metal on each side and at the same time, tool *3* is taking a rough facing cut. With the conclusion of the heavy roughing cuts the first finishing operation is to turn the 7¼-in. external diameter and bore the 85 mm. and 6-in. diameter, leaving about .007 in. for reaming with tool set up *5*. These tools consist of a boring bar with cutter for boring 85 mm. diameter and a tool in the holder clamped to the bar for boring the 6-in. diameter all held in a turning tool holder over the face of the turret. The tool for turning the external diameter is held in a fine adjustment tool holder, thus insuring quick and accurate setting. The boring tools are also adjustable by screws operating underneath them.

The two recesses are next faced and the 6-in. diameter undercut with the tools shown in tool set up *6* on the square turret. The chamfer is finished and also the front face with tool *7* inverted in the holder on the back of the cross slide. This eliminates a great deal of chatter, which



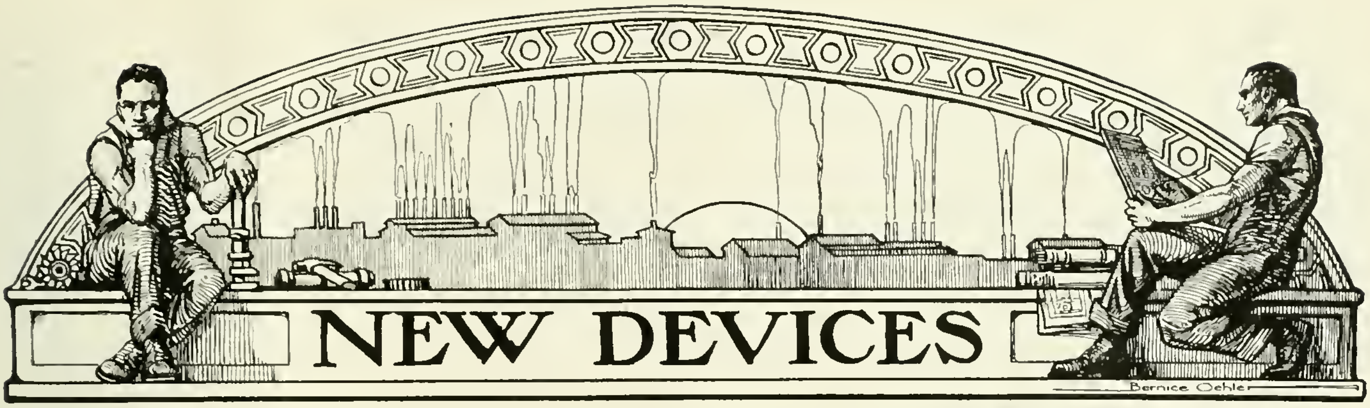
Tool Set Up 6; Recess and Undercutting Operation

is liable to occur on broad chamfers when machining from the front tool post.

The 85 mm. and 6-in. bores are finish reamed with floating cutters, *8* and *9*, each of these reamers consisting of two high-speed cutters floating in a slot in a steel holder. They have adjusting screws which enable the cutters to be kept up in size and are held in position by two filister head screws locating against a step in the back of the cutters. The heads of the screws have a flat milled way across them and when the cutters require regrinding, the screws are turned until the flat part clears the step in the cutters, which are then withdrawn. This method helps to make the regrinding a very quick operation.

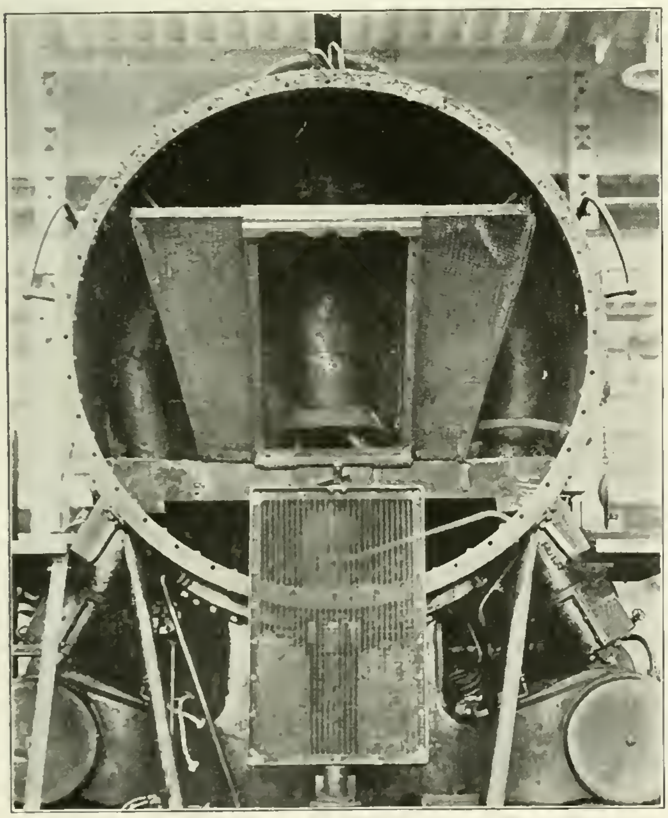
All boring tools are equipped with an oil feed from the turret giving a direct supply of lubricant to the point of cutting, thus insuring the maximum cooling and also lengthening the life of the tools.

Rotatable Coal Hopper for Locomotives.—Firemen on big locomotives find promise of lightened work in the rotatable coal hopper that has been invented for engine tenders. This invention is so planned that the coal is kept handy at the firing deck, making it an easy matter for the firemen to reach the coal without shoveling from the rear of the tender or using power apparatus. This special hopper is in the form of a great segmental tub, or drum, having a diameter that is the approximate width of the tender. This drum is inclined toward the firing deck; it is so mounted on a ball-bearing center plate as to turn readily. In its outer wall are openings, one for each segment, through which the coal falls by gravity. As soon as the coal is emptied from the segment, the brake that controls the drum is released. Naturally the greater weight above the center of the drum makes it rotate, bringing the next loaded segment into position.—*Scientific American.*



Quick Opening Door in Front End Netting

A FRONT end netting door, which may quickly be removed and replaced and which has sufficient area of opening to facilitate thorough and rapid inspection of the spark arrester and draft appliances, is shown in the illustrations. This device was developed and patented by John Herron, general foreman, Duluth, South Shore & Atlantic, Marquette, Mich., and the patents are controlled by Mr. Herron and John A. Higgins, Manistee, Mich. The features

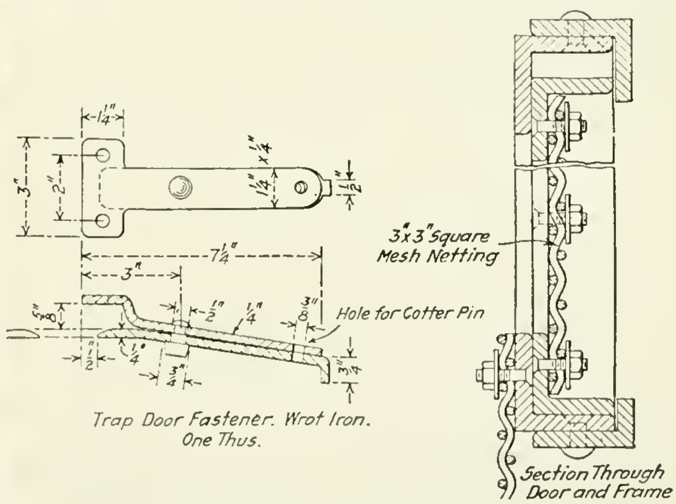


The Door Applied to a Mudge-Slater Spark Arrester

of this device which are of especial interest are the size of the door opening, the fact that it is locked in place by the use of one cotter key and the simplicity and rigidity of the door and door frame.

By referring to the drawing it will be seen that the entire device is built up of angle sections, the door itself being of ½-in. by ½-in. section, while the door frame is of 1 ¾-in. by 1¾-in. section. Both are built up by cutting 90-deg V-notches in the horizontal flanges of the angles at points corresponding to the corners, then forming the frames by bending the vertical flanges at these points and completing the structure by welding. The door and frame angles are then fitted with countersunk bolts and the netting secured in place by the application of washers and nuts. The relative sizes of the door and frame are such that the door itself fits inside of the frame with an easy working fit. The door is held in place by retaining angles riveted to the top and bottom of the door frame, the vertical flanges of which extend up or down, as the case may be, in front of the door when it is placed in the frame.

Aside from the retaining angles which prevent the door from being removed without raising it in the frame, it is also



Details of the Herron Spark Arrester

secured by a simple fastener which is locked by the use of a single cotter key in a ⅜-in. hole. This fastener, which is shown in detail in the drawing, consists of two parts, one of which is riveted to the bottom of the door. A movable piece is pivoted to the fixed piece in such a way that when it is latched under the door frame it lies under the fixed piece, to which it is immovably secured by the use of a cotter key. To unlock the door the key is removed and the movable piece turned parallel to the face of the netting, when the door may be raised and removed from the frame.

This door has been in use on a large number of the locomotives of the Duluth, South Shore & Atlantic since 1917 and is also being applied to a number of locomotives on other railroads. In many localities where there is serious danger of fires from locomotive sparks during the dry season, inspection of the spark arrester is required as frequently as once in 24 hrs. Under such conditions the convenience of a quick opening netting door of large area is apparent.

Sibley Stationary Head Drilling Machine

A NEW stationary head drilling machine built in 24 in., 26 in. and 28 in. sizes has been placed on the market recently by the Sibley Machine Company, South Bend, Ind. This machine is provided with positive geared feed, back gears and in general is modeled after the sliding head drilling machine described on page 173 of the March, 1920, *Railway Mechanical Engineer*.

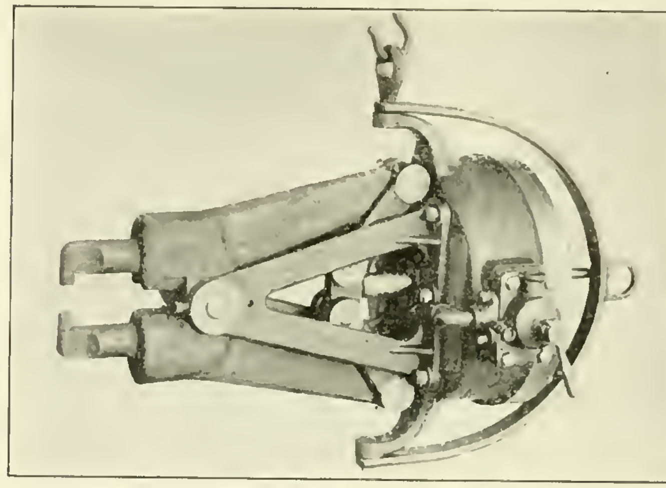
Designed to meet modern production requirements, the machine is strongly made with a base which is well ribbed and braced, with tee slots provided for clamping work. Increased length of bearings on the head and arm and a substantial table support give additional strength and accuracy. The speeds and feeds are selective and have a wide range. The spindle is balanced by a weight supported inside the column with a Diamond chain operating over large diameter sheaves. The safety of the operator is assured by enclosing the gears.

A positive geared tapping attachment, geared or belted motor drive, round or square table, with oil pump or a quarter-turn countershaft can be furnished as special equipment.

Staybolt Cutter Adapted for Riveting

THE staybolt cutter, manufactured by the Baird Pneumatic Tool Company, Kansas City, has been adapted for riveting purposes by certain alterations shown in the illustration. This makes a double purpose tool and one which has another distinct advantage, namely: adaptability for close corner work. The tool is constructed along the same principles as the regular line produced by the Baird Company, but special arms and dies enable work to be performed in extremely close corners. Fifty tons pressure exerted on the dies enables 5/16 in. rivets to be driven cold. This tool can be used to good advantage in many places which would be practically inaccessible to a hand hammer and rivets can be more uniformly driven than by hand.

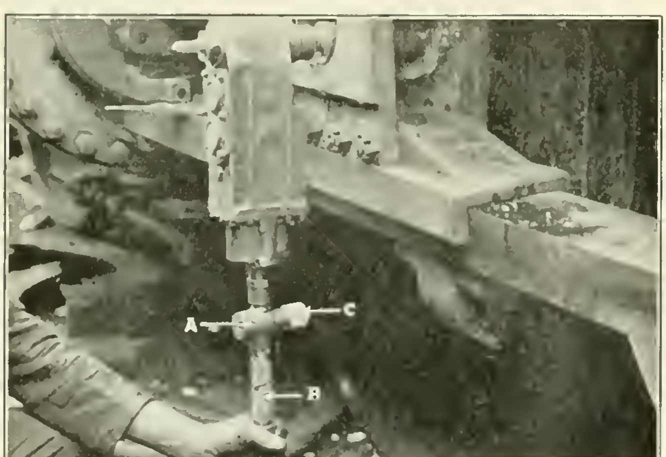
The machine is composed of a 15 in. air cylinder, the piston head of which connects directly through a powerful toggle movement with a pair of lever arms. The removable riveting dies are securely fastened in the lever arms. On account of light construction and conveniently placed control valves, the machine can be operated by one man.



Fifty Tons Pressure Is Exerted on Riveting Dies

Safety Valve for Pneumatic Motors

A PNEUMATIC safety valve combining simplicity, strength and durability, has been placed on the market by the Pneumatic Safety Valve Company, Woonsocket, R. I. This valve is designed to prevent accident to machine operators, increase production and reduce the injury and breakage of cutting tools, such as drills, reamers, taps, etc. It is made in one size only for Nos. 1, 2, 3 and 4 non-reversible rotary machines and its use does not necessitate any extensions, alterations or change from present equipment.



Safety Valve Applied to Motor

In operation the valve is attached directly to the machine in place of the customary air control handle. The air hose is then attached to a specially constructed handle furnished with each valve, and the machine operated in the usual way. The valve consists of a body *A*, control valve *B* and cap nut *C* for regulating the pressure. If the air pressure is at 85 lb., the cap nut can be turned down, thereby tightening the spring tension of the valve until air passes freely to the machine. When the cutting tool jams or binds by reason of abnormal resistance, a back pressure is instantly created within the valve chamber which closes the valve, shutting off the air and preventing the kick of the machine, which usually causes injury or damage. When the valve closes it cannot open and the machine cannot resume action until the operator closes the air control valve, which operation releases the valve to its normal position and opens the air line to resume work.

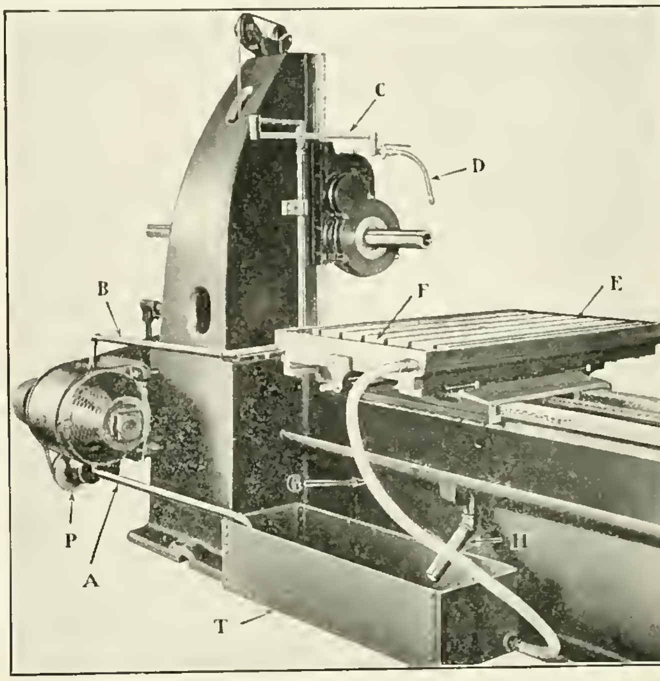
The pneumatic safety valve is made of standard design, all parts being interchangeable and can be taken apart, cleaned, oiled and reassembled in approximately three minutes. It is stated that this valve has been used in summer or winter with dependable results and withstood severe tests under all working conditions. Many accidents should be obviated by its use.

Cutting Lubricant System for Boring Machine

An efficient and complete cutting lubricant system has been applied to the horizontal boring machine manufactured by the Universal Boring Machine Company, Hudson, Mass. This addition is in line with the recent tendency of modern machine tool manufacturers to increase the production of their machines to the maximum by furnishing an abundant supply of cutting compounds or lubricant to the cutting tool. Heat must be carried away from the cutting edge of the tool where the work is being done and for this purpose it is better to supply too much rather than too little compound.

In order to supply an adequate amount of cooling compound, an impeller type pump *A* with a capacity of 12 gal. per min. is attached to the motor bracket and driven by a belt upon the motor shaft. The reservoir or tank *T* holds the excess compound which flows to the pump through an intake pipe *A*. It is stated that the impeller type pump cannot lose its prime and that chips cannot stick and clog the system because anything that enters *A* can pass through the pump and all pipes. This avoids the necessity for strainers. The impeller pump by centrifugal force sends the compound through the delivery pipe *B*, various fittings, pipes and flexible tubes *C* and *D* to the cutting edge of the tool. The flow of compound is controlled by a valve shown.

The table has oil pockets *E* and *F*, at each end connected by grooves and from oil pocket *F*, the cutting compound is delivered to tank *T* by a flexible tube *G* of ample diameter. The machine bed has oil troughs on the front and back sloping towards the center. The front trough is on a higher level than the rear and lubricant is carried from the front to the rear trough by means of a 1¾-in. pipe. The lubricant accumulates in the rear trough and passes to the tank through overflow pipe *H*. The flexible tube *D* facilitates the flow of the compound in any direction desired. The cutting lubricant system described is applied to universal boring machines only on special order.

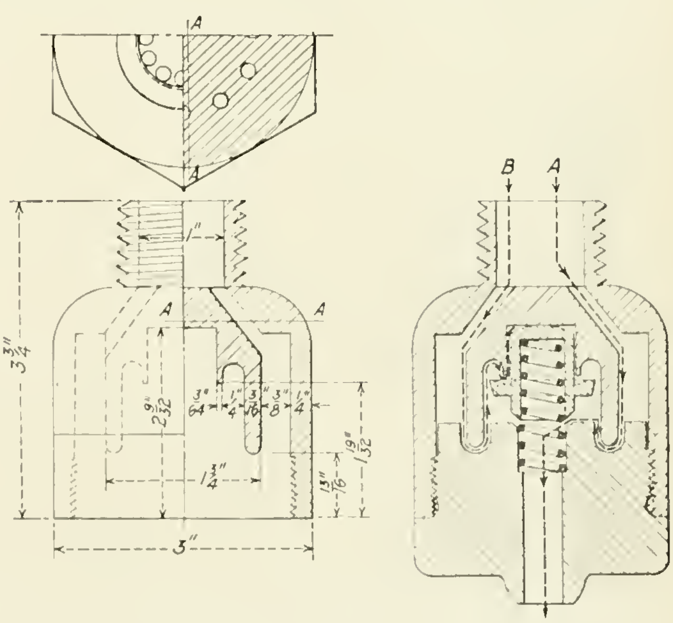


Universal Boring Machine With New Cutting Lubricant System

K & N Automatic Cylinder Cock

The automatic cylinder cock, illustrated, is simple in construction and operation, being actuated by the difference in specific gravity of steam and water, and is reported to have given satisfactory results in regular daily service for more than ten months. Cylinder cocks of this type are screwed into the cylinders in the same places previously occupied by the old style cocks. No change is required except the elimination of the train of connecting rods and levers from the cab to the cocks.

Referring to the illustration, the central valve is kept from its seat by a spring when not subjected to steam pressure. This permits unobstructed passage for water, from the cylinders to the atmosphere. When steam is turned into the pipes it forces any water which may be there ahead of it to the cylinder cocks, which remain open. The water, because of its greater weight, will not follow the same path as the steam but flows out over the valve seat in the direction *A* indicated by the arrows. When the water has drained and been blown out it leaves an unobstructed passageway for steam, which because of its greater speed and less weight follows the other path *B* shown by the arrow, bringing it in a jet against the upper face of the inclined ring mounted on the valve. The jet of steam closes the valve against the action of the spring and the interior chamber fills with dry steam which fills the cylinder where the piston travels and exerts a downward pressure on the piston. This makes the downward pressure greater than the upward pressure plus the force of the spring. The cock is kept closed as long as steam pressure is on it, but when condensation occurs, the accumulated water will shut off the admission of live steam; the valve opens due to decreased pressure, and the condensation is blown out. The same process is repeated as steam is allowed to enter the valve chamber again.



Cylinder Cock Which Operates Without Levers or Connecting Rods

The above action eliminates the necessity of blowing out the cylinder cocks when starting and making the disagreeable alternating hissing sound which is so familiar and

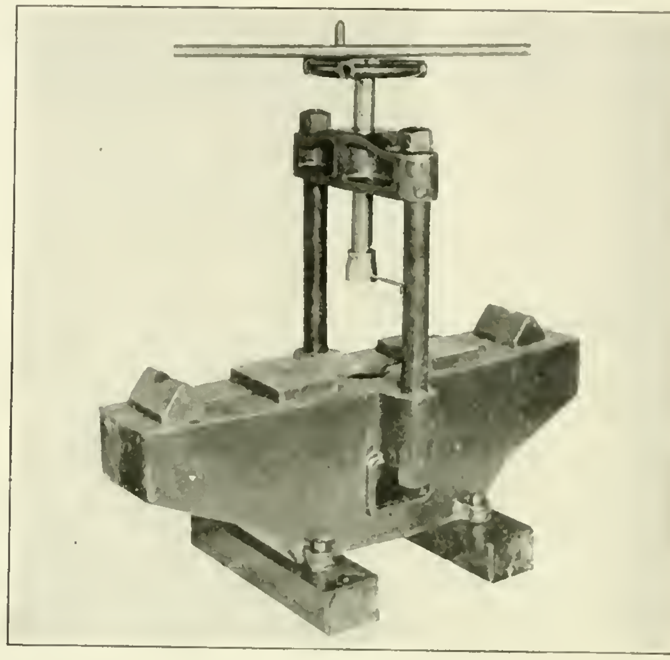
annoying. The valve remaining open precludes the possibility of freezing up in winter and the starting of engines due to leaking throttle valve. It has been proved by test that the central valve does not hammer its seat. Patents for the K & N automatic cylinder cock have been applied for by W. F. Koon and C. R. Nordberg, Duncansville, Pa.

Utility Screw Press a Handy Device

ONE of the handiest tools in a shop is a screw press. The Utility screw press illustrated can be used to straighten shafts, bars, rails, beams, etc. It is also arranged to press in or out bushings; press gears or wheels on and off shafts; and form or bend metal in many shapes. It is made by Carl Pletz & Sons, Cincinnati, Ohio.

The bed is 4 ft. long, deep and heavily ribbed with a hole cored under the screw to permit work to drop through to the floor when pressed out. These cored holes permit the pressing of pieces on or off long shafts. The two upright posts are more than strong enough to withstand any load that can be applied with the screw. A pad fits on the end of the screw and the thrust is taken on a hardened steel and bronze washer which sets in oil. The hand wheel on the end of the screw is fitted with a handle so that the screw can be returned quickly. By using a 4-ft. bar in the hand wheel, a pressure of 20 to 25 tons can be secured.

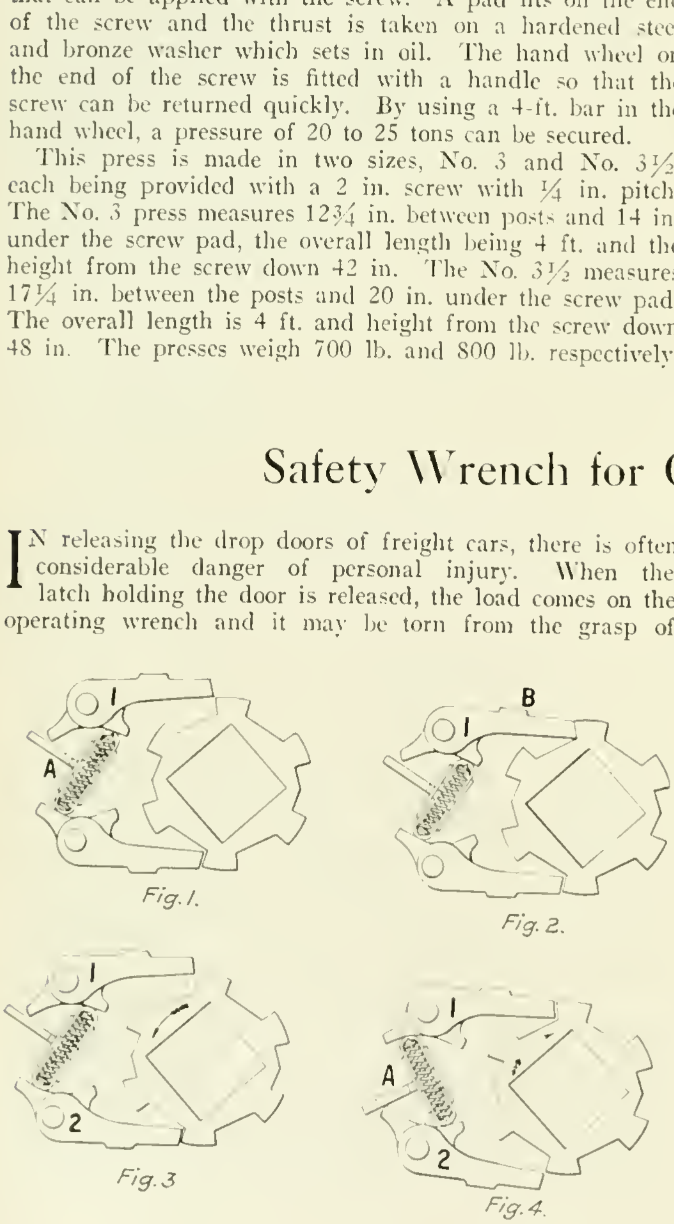
This press is made in two sizes, No. 3 and No. 3½, each being provided with a 2 in. screw with ¼ in. pitch. The No. 3 press measures 12¾ in. between posts and 14 in. under the screw pad, the overall length being 4 ft. and the height from the screw down 42 in. The No. 3½ measures 17¼ in. between the posts and 20 in. under the screw pad. The overall length is 4 ft. and height from the screw down 48 in. The presses weigh 700 lb. and 800 lb. respectively.



Utility Screw Press for Shop Work

Safety Wrench for Opening Car Hoppers

IN releasing the drop doors of freight cars, there is often considerable danger of personal injury. When the latch holding the door is released, the load comes on the operating wrench and it may be torn from the grasp of the man using it. To avoid the possibility of accident from this cause, a special type of ratchet wrench is now being made by the Safety Wrench & Appliance Co., Philadelphia. Pa. This device, which is known as the "Swaco" safety hopper car wrench, allows quick manipulation with assurance of safety.



Ratchet Mechanism of the Swaco Wrench

The mechanism of the wrench is so arranged that the top pawl is automatically thrown to the safety position when the wrench is lowered. Referring to the drawing, the operations in releasing the shaft to open the door are as follows: The spring lever, *A*, is thrown up as shown in Fig. 1, to force the top pawl *1* out of engagement with the ratchet. The wrench is then placed on the hopper shaft. By placing a finger at *B*, the pawl *1* is pressed down to engage with the ratchet. The operator then pulls up on the wrench handle to take the load off the pawl on the door frame which is lifted out of engagement, leaving the load on the wrench. By quickly lowering the wrench handle, pawl *1* is freed from the ratchet, the load rotating the ratchet in the direction shown. Should the door stick, the shaft can be revolved by pushing down on the wrench. To close the door, the spring lever, *A*, is reversed as shown in Fig. 4 to throw pawl *2* out and pawl *1* into engagement.

The "Swaco" hopper car wrench has a ball bearing head and the entire wrench is made from electric steel castings of high tensile strength. The socket is designed for holding 2 in. square shafts and bushings or reducing sockets are used to fit smaller sizes. This device is being used by railroads and also by many industrial firms.

The American Welding Society has authorized the organization of a new section of the society in Cleveland. Preliminary steps have been taken and a meeting will be held shortly to effect an organization.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 10,950 copies were printed; that of these 10,950 copies, 9,603 were mailed to regular paid subscribers, 13 were provided for counter and news company sales, 261 were mailed to advertisers, 32 were mailed to employees and correspondents, and 1,041 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 116,100, an average of 11,610 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The Southern Pacific is planning to enlarge and improve its car shops in Sacramento, Cal. New buildings will be provided for the foundries, rolling mills and general shops.

The Southern Railway has put in service 1,093 freight cars since March 1, when the railways were returned to their owners; and new cars are being completed at the rate of eight cars a day. This equipment consists of 555 new steel underframe box cars and 538 steel frame coal cars, rebuilt from bad-order cars which were totally unfit for service and past the stage for economical repair.

A technical adviser from the United States has just completed a tour of inspection in connection with a large scale electrification scheme for the Austrian State Railways, according to the Scientific American. He commends the policy of the Austrian government in developing water resources to provide the necessary power and the decision to commence the work of railway electrification by converting the mountainous route to electric traction. He makes the definite statement that the electrification of the lines from the Swiss frontier to Innsbruck will save 150,000 tons of coal a year.

Chief Interchange Inspectors' and Car Foremen's Convention

The Chief Interchange Car Inspectors' and Car Foremen's Association held its twentieth annual convention at the Windsor Hotel, Montreal, P. Q., September 14-16. At the session on Tuesday morning, the convention was opened with prayer and an address of welcome was delivered by Alderman J. P. Dixon representing Mayor Martin of Montreal. T. J. O'Donnell responded to Alderman Dixon's remarks on behalf of the association. In the presidential address which followed, J. J. Gainey emphasized the benefits derived from the activities of the association in advancing knowledge regarding car construction and maintenance and promoting a uniform understanding of the A. R. A. rules and interchange matters in general. At this session there was also presented a paper on Transfers and Adjustments of Lading under the A. R. A. rules for Mechanical Defects, by J. M. Gitzen.

The meeting on Tuesday afternoon was devoted to a discussion of the A. R. A. Rules of Interchange with particular attention to the changes adopted at the June convention. This discussion was continued on Wednesday morning and at the conclusion a paper on the Transportation of Explosives was read by J. E. Grant of the Bureau of Explosives. An address on the same subject was given by J. O. O'Donnell, also representing the bureau. The influence of the work of the car department on the elimination of loss and damage to freight was discussed by E. Arnold, freight claim agent of the Grand Trunk.

Two papers were presented at the meeting on Wednesday afternoon, the first on the Lubrication of Freight and Passenger Equipment by M. J. O'Connor; the second on the Best Methods of Repairing Cars in Train Yards by O. E. Sitterly. An interesting feature of this session was the showing of moving pictures illustrating proper and improper practices in designing and maintaining brake beams and brake shoes, prepared by the Chicago Railway Equipment Company. The meeting on Thursday was devoted to the reports of committees, the election of officers and miscellaneous business.

The officers chosen for the year 1920-1921 are as follows: President, E. Pendleton, C. & A.; first vice-president, A. Armstrong, Atlanta, Ga.; second vice-president, W. F. Westall, N. Y. C.; secretary-treasurer, W. P. Elliott, T. R. R. A. of St. L. Members of the executive committee: W. H. Sherman, Grand Trunk, and A. Herbster, N. Y. C. A complete convention report will be published in the November issue.

The Railroad Administration Settling Claims

The Railroad Administration has reached a settlement in the cases of approximately 2,000 claims filed by railroad companies on account of items of additions and betterments made during the period of federal control which the companies claimed were made for war purposes or in connection with unification and, therefore, were properly chargeable to the government rather than to the companies. The greater part of the claims have been rejected, although payments were agreed upon by the Railroad Administration amounting to approximately $217,000. The claims which it has rejected or which were withdrawn during the negotiations amounted to approximately $2,000,000. The Railroad Administration has now received complete claims covering all items of account between the companies and the Railroad Administration from 43 companies.

Lehigh Valley Employee-Stockholders

More than 1,000 employees of the Lehigh Valley have purchased stock in the company and additional subscriptions are being received daily. Recently employees were advised that they might become part owners of the railroad for which they work through the purchase of stock which could be paid for on the installment plan through small monthly deductions from the payroll, as was done during the several Liberty Loan campaigns. The company buys the stock on orders from employees and they pay the price prevailing at the New York Stock Exchange on the day their orders are

received. No drive was made, President E. E. Loomis having ordered that employees were not to be urged to purchase stock, but the first 1,000 purchasers have taken an average of 4.4 shares apiece, representing an investment of approximately $200,000 at the present value of the stock. All classes of employees are represented among the purchasers, many using a part of the back pay recently received.

ALL LOCOMOTIVES ON THE M. K. & T. TEXAS LINES TO BE OIL BURNERS

Estimates compiled by the Missouri, Kansas & Texas as to the cost of operating oil-burning locomotives showed that they are more economical than those using coal, to the extent that the road is spending more than $700,000 to convert all of the 315 locomotives operating on its Texas lines to burn oil fuel. This is a statement of one of the officers of the road published in the daily press. It is expected that the transformation will be completed by January, 1921. About 160 oil-burning locomotives, both passenger and freight, are now in use on the Texas lines of the Missouri, Kansas & Texas. The cost of converting one locomotive from coal to oil burning is stated to be about $1,600. The installation of oil stations and storage tanks to serve the locomotives has been practically completed, at a cost of approximately $200,000, an oil station having been installed at practically every place where a coal filling station was located.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association. F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Section III.—Equipment Painting Division. V. R. Hawthorne, Chicago.

American Railroad Association, Section VI. Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association. C. B. Baker, Terminal Railroad, St. Louis, Mo.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating. W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411 C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting October 12, Paper on Inventions for Patents will be presented by W. P. McTeat, Patent Solicitor, 83 Craig St., West, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Friday in January, March, May and September, and second Thursday in November, Hotel Statler, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A., St. Louis.

Cincinnati Railway Club.—H. Boutet, 101 Carew Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va. Next meeting November 8-9, Atkin Hotel, Knoxville, Tenn.

International Railroad Master Blacksmiths' Association. W. J. Mayer, Michigan Central, Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting October 12. Paper on What the Recent Freight and Passenger Rate Increases Mean to the Public will be presented by Garritt Fort, B. & M.

New York Railroad Club. H. D. Vought, 95 Liberty St., New York. Next meeting October 15. Paper on The Human Element in Railroading will be presented by W. S. Wollner.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting October 7. Ten-minute talks on More Transportation by railroad men and shippers.

Railway Club of Pittsburgh. J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Friday in month, except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—J. B. Frauenthal, Union Station, St. Louis, Mo. Next meeting October 8. Paper on Industrial Conditions will be presented by R. D. Sangster, Industrial Commissioner, St. Louis Chamber of Commerce.

Traveling Engineers' Association. W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, Chicago. Next meeting October 18.

PERSONAL MENTION

GENERAL

R. M. Brown has been appointed engineer of motive power of the New York Central, with headquarters at New York. The position of engineer of motive power and equipment has been abolished.

Charles H. Hogan, who has been appointed manager, department of shop labor of the New York Central, with headquarters at Buffalo, N. Y., as noted in the August *Railway Mechanical Engineer,* served as assistant superintendent of motive power of the first district, with headquarters at Albany, N. Y., previous to this promotion. Mr. Hogan was born in Cleveland, Ohio, on January 9, 1850. He received a public school education and began railroad work as a track worker for the New York Central on April 1, 1865. From 1867 to 1871 he served the Union Pacific, first as fireman and later as engineer. He then returned to the New York Central as locomotive engineer and filled that position until 1893, when he was appointed traveling engineer. In 1900 he was promoted to master mechanic and in May, 1904, he became division superintendent motive power, with headquarters at Depew, N. Y. On August 1 1910, he was appointed assistant superintendent motive power at Albany, as mentioned above.

C. H. Hogan

Henry Wanamaker, who has been appointed district superintendent of motive power of the New York Central, with headquarters at Albany, N. Y., as noted in the August *Railway Mechanical Engineer,* served as superintendent of shops previous to this promotion. Mr. Wanamaker was born on August 5, 1866, at Pottsville, Pa. He received a high school education and began railroad work on August 1, 1884, with the Philadelphia & Reading, as a machinist apprentice. He was promoted to machinist in 1888 and served in that capacity until 1896, when he was appointed gang foreman at Reading, Pa. He left the Philadelphia & Reading in 1900 to become a foreman in the erecting shops of the New York Central at West Albany, N. Y., where he remained until 1905, when he was transferred to Depew, N. Y., as general foreman. In December, 1911, he was appointed superintendent of shops, with the same headquarters, and was transferred to West Albany on May 20, 1912.

H. Wanamaker

G. E. Doke, engineer of materials of the New York Central, with headquarters at Collinwood, Ohio, has been appointed engineer of tests, with headquarters in New York.

A. H. Eager, mechanical superintendent of the Canadian National, with headquarters at Winnipeg, Man., has been given jurisdiction over the lines of the Grand Trunk Pacific, in addition to his former duties. He will retain his former headquarters.

F. S. Gallagher has been appointed engineer of rolling stock of the New York Central, with headquarters at New York.

R. D. Hawkins, equipment engineer of the Great Northern, with headquarters at St. Paul, Minn., has been appointed general superintendent of motive power of the Atlantic Coast Line, with headquarters at Wilmington, N. C. Willard Kells has been appointed superintendent of motive power, with the same headquarters.

Laird W. Hendricks has been appointed mechanical superintendent of the Bangor & Aroostook, with headquarters at Bangor, Me., succeeding H. Shoemaker.

F. A. Linderman, district superintendent of motive power of the New York Central, with headquarters at Oswego, N. Y., has been made division superintendent of motive power.

S. J. Lupton, chief boiler inspector of the Canadian National, with headquarters at Winnipeg, Man., has been given jurisdiction, also, over the lines of the Grand Trunk Pacific.

S. Watson has been made division superintendent of motive power of the New York Central at Avis, Pa., the office of district superintendent of motive power having been abolished.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

C. L. Bunch has been appointed master mechanic of the Southern Railway at Meridian, Miss., succeeding H. M. Little, who has resigned.

H. E. Dyke has been appointed master mechanic of the Southern Railway at Sheffield, Ala., succeeding C. L. Bunch.

Albert G. Hentz, whose appointment as master mechanic of the Harlem and Putnam divisions of the New York Central, with headquarters at West Albany, N. Y., was announced in the August issue, was born on May 20, 1889, at West Medford, Mass. He received the degree of mechanical engineer at Harvard University in 1909 and entered the employ of the New York Central on July 16, 1909, as a special apprentice at Avis, Pa. From July 1, 1911, until October 1, 1911, he served as a special engineer. He then became assistant engine-house foreman and acted in that capacity until October 1, 1912, when he was made erecting shop foreman. On July 1, 1916, he was transferred to New York city as a traveling inspector for the equipment engineering department and on July 8, 1918, was promoted to assistant master mechanic of the Mohawk division. He held that position until July 1, 1920, when his recent appointment became effective.

A. G. Hentz

E. L. Notley has been appointed division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Ia., succeeding C. L. Emerson.

Jesse E. Stone, whose appointment as assistant master mechanic of the Southern Pacific, with headquarters at Sparks, Nev., was announced in last month's issue, was born on June 19, 1885, at Shoshone, Idaho. He graduated from the grammar school at Pocatello, Idaho, in April, 1901, and entered the service of the Oregon Short Line on August 27, 1902, as a machinist apprentice at Pocatello. After completing his apprenticeship, on August 27, 1906, he was promoted to shop draftsman. On January 1, 1909, he was transferred to the office of the superintendent of motive power in Salt Lake City, Utah, as a mechanical draftsman. In April, 1911, he left the employ of the Oregon Short Line and for about a year was employed as a mechanical draftsman by the Ray Consolidated Copper Company at Ray, Ariz., returning to the Oregon Short Line on May 16, 1912, as assistant machine shop foreman at Ogden, Utah. On November 15, 1913, he was promoted to general foreman. On July 1, 1914, the shops at Ogden were turned back to the Southern Pacific, and he continued as general foreman there until August 1, 1920, when his recent appointment became effective.

CAR DEPARTMENT

J. Matthes has been appointed chief car inspector of the Wabash with headquarters at Decatur, Ill., succeeding J. C. Keene.

Andrew McCowan, master car builder of the Canadian National, with headquarters at Winnipeg, Man., has had his jurisdiction extended to the lines of the Grand Trunk Pacific. The change was effective September 1.

E. Hacking, master car builder of the Grand Trunk Pacific, with headquarters at Transcona, Man., has been promoted to assistant master car builder of the Canadian National, with headquarters at Winnipeg, Man.

SHOP AND ENGINEHOUSE

C. G. Henderson has been appointed general foreman of the Southern Railway at Chattanooga, Tenn., succeeding H. E. Dyke.

V. B. Story has been made general foreman of the Rock Island shops at Amarillo, Tex., succeeding S. C. Thomas, resigned.

PURCHASING AND STOREKEEPING

George W. Grossner has been appointed purchasing agent of the New Orleans Great Northern, with headquarters at New Orleans, La., succeeding William Grentzenberg, resigned.

Henry Hansen, chief clerk to the purchasing agent of the Northern Pacific, has been appointed assistant purchasing agent, with headquarters at St. Paul, Minn.

W. C. Livingstone has been appointed division storekeeper of the Pittsburgh division of the Pennsylvania, with headquarters at Derry, Pa.

OBITUARY

Isaac B. Thomas, purchasing agent of the northwestern region of the Pennsylvania with headquarters at Chicago, died on September 1 in that city. Mr. Thomas was born on June 26, 1872, at West Chester, Pa. He was graduated from Sheffield Scientific School, Yale University, in 1892. In that year he began railroad work as an apprentice at the Altoona shops of the Pennsylvania. On August 1, 1897, he was promoted to the position of inspector at the Altoona shops, and in April, 1899, was transferred as inspector to the office of the assistant engineer of motive power. On February 1, 1900, he was appointed assistant master mechanic at Renovo, Pa., returning to Altoona in 1901 as assistant engineer of motive power. On August 1, 1903, he was appointed master mechanic of the Pittsburgh shop and was transferred to the Altoona machine shop in 1906. He was promoted to superintendent of motive power of the Erie division of the Pennsylvania and also of the Northern Central, with headquarters at Williamsport, Pa., in 1911, and was appointed assistant purchasing agent of the Pennsylvania lines east of Pittsburgh in 1916. Upon the return of the road to private control he was appointed to the position he held at the time of his death.

I. B. Thomas

SUPPLY TRADE NOTES

George J. Lynch has resigned as sales manager of the Youngstown Steel Car Company, Niles, Ohio.

Joseph S. Ralston, president of the Ralston Steel Car Company, Columbus, Ohio, died in that city on September 11, at the age of 55.

J. C. Keene, chief car inspector of the Wabash at Decatur, Ill., has accepted a position with the Bradford Draft Gear Company, Chicago, Ill.

H. D. Elvidge, assistant to the advertising manager of the Reading Iron Company, Reading, Pa., has been appointed assistant advertising manager.

Agnew T. Dice, Jr., railroad sales manager of the Reading Iron Company, Reading, Pa., has been placed in charge of the cut nail business of the company.

D. M. Brown has been appointed manager for Ontario, with headquarters at 342 Adelaide street West, Toronto, of the Holden Company, Ltd., Montreal, Que., dealers in railway supplies.

The American Automatic Connector Company, Cleveland, Ohio, on October 1 opened offices and an exhibit room at 235 Railway Exchange building, Chicago, in charge of F. R. Bolles, vice-president and general manager.

The American Steam Conveyor Corporation of Chicago, Ill., announces that a change has been made in the corporate name to Conveyors Corporation of America. There is no change either in the personnel or policy of the company.

Benjamin M. McDade, formerly sales manager of the Detroit Red Lead Works, Detroit, Mich., has become associated with the railway sales department of the Sherwin-Williams Company, with headquarters at Detroit, Mich.

L. R. Day has succeeded W. E. Allison as representative in the railroad department of the Western Electric Company at Milwaukee, Wis. E. B. Dennison has been appointed manager of the new branch office at Nashville, Tenn.

C. E. Neubert, assistant district manager of the Chicago office of the Warner & Swasey Company, Cleveland, Ohio, has been promoted to district manager of the company's office in Buffalo, N. Y., to succeed W. E. Marshall, deceased.

S. W. Fries has been appointed district sales manager for Kansas City territory of the Economy Fuse & Manufacturing Company, Chicago, with offices at 1205 Commerce building, Kansas City, Mo. Mr. Fries succeeds R. P. Crawley, resigned.

John G. Talmage, president of the Talmage Manufacturing Company, Cleveland, Ohio, died suddenly in Washington, D. C., on August 25. Mr. Talmage founded the company bearing his name in 1896 and was the active head of the same up to the time of his death. Mr. Talmage contributed many appliances in the development of the locomotive.

A company is being organized to construct freight car repair plants at St. Paul, Minn., and Minneapolis which will have capacities to repair 6,000 cars annually and can later be enlarged to handle 15,000 cars per year. The company is now in the market for machine tools and appliances suitable for equipping a modern plant of this type. Claude H. Siems, Alan G. Siems and C. C. Semple are the promoters and the company's headquarters are in the Guardian Life building, St. Paul, Minn.

James T. Lee has been added recently to the sales engineering staff of the Southwark Foundry & Machine Company, Philadelphia, Pa. Mr. Lee for several years past was vice-president in charge of sales of the Hanna Engineering Works, Chicago. It is the purpose of the Southwark Foundry & Machine Company to greatly broaden its field of activity by adding to its present complete line of hydraulic and power machinery a full line of pneumatic riveters and foundry molding machines.

Charles H. McCormick has been appointed western representative of the railroad department of the Standard Paint Company, New York, with headquarters in the Plymouth Building, Chicago. Mr. McCormick began railway work with the Michigan Central in the mechanical department at Bay City, Mich., and later was transferred to Jackson, Mich., and Detroit, at the latter place serving as chief clerk to the superintendent of motive power for six years. He later went to the Standard Heat and Ventilation Company, at New York and Chicago, for four years, and was with the Hegeman-Castle Corporation, at New York and Chicago, for four years previous to entering the service of the Standard Paint Company.

The East St. Louis Locomotive & Car Company, capitalized at about $5,000,000 will establish a railroad car and locomotive building and repair plant at East St. Louis, Ill. The plant, it is stated, is ultimately to employ 3,000 men. R. W. Crawford, formerly head of a car building plant at Streator, Ill., is president of the company. Options have been obtained on three sites, according to J. N. Fining, secretary of the East St. Louis Chamber of Commerce, and it is planned to begin work at once on several buildings. The plant, with buildings and tracks, is expected to cover 150 acres and to have an output of 75 to 120 freight cars per day. The company expects to be in a position to begin repair work on cars this winter.

B. B. Milner, heretofore engineer of motive power and rolling stock of the New York Central, at New York, who has become associated with the Frazar importing and exporting interests, as was announced in the *Railway Mechanical Engineer* for August, was born on November 5, 1881, at Hartford, Kans. In 1899 and 1900 he worked in the Parsons shops of the Missouri, Kansas & Texas, and later entered the mechanical engineering school of Purdue University, from which he was graduated in 1904. He then entered the service of the Pennsylvania as a special apprentice at Altoona. In 1907 he was in charge of arranging a complete revision of the machine tool layout at the Altoona shops, and later visited the principal railroad terminal points in a study of operating and maintenance of equipment methods. In 1908 he served in the office of W. W. Atterbury, then general manager at Philadelphia, on various betterment studies and was engaged in the introduction of improved operating statistical information. In May, 1911, he was appointed assistant master mechanic of the Philadelphia, Baltimore & Washington (now the Southern division of the Pennsylvania), at Wilmington, Del. In October, 1913, he left the service of the Pennsylvania to go to the New York Central as special engineer on the staff of the senior vice-president, A. H. Smith, and was sent to the Cleveland, Cincinnati, Chicago & St. Louis to assist in re-establishing satisfactory operating conditions after the disorganization precipitated by the floods of that year. He continued as special engineer on the staff of Mr. Smith, who had been made president, and later was appointed engineer of motive power of the New York Central under Chief Mechanical Engineer R. B. Kendig. In addition to duties as engineer of motive power, he handled problems in connection with car department work and the organization and administration of the test department headed by the engineer of tests. On May 10, 1917, Mr. Kendig died and Mr. Milner took over his entire work through the war and United States Railroad Adminis-

B. B. Milner

tration period. During the latter half of 1918, or until after the armistice was signed, he assisted H. A. Worcester, the Ohio-Indiana district director, with headquarters at Cincinnati. When the railroads were returned to their owners for operation on March 1, 1920, he became engineer of motive power and rolling stock, which position he held until he joined the staff of Sale & Frazar, Ltd.

W. H. S. Bateman, trading as W. H. S. Bateman & Co., Philadelphia, Pa., who for the past six years has been the eastern representative of the Canton Sheet Steel Company, has severed his connection with that company and has been appointed eastern sales agent of the Superior Sheet Steel Company, Canton, Ohio, with offices in the Commercial Trust building, Philadelphia, Pa., and 30 Church street, New York. Joseph R. Wetherald will continue as sales manager at the Philadelphia office and Richard J. Sheridan at the New York office. Mr. Bateman will continue as resident sales manager of the Parkesburg Iron Company and eastern and southern sales agent of the Champion Rivet Company, at Philadelphia.

Announcement is made of the consolidation of the Whiting Foundry Equipment Company of Harvey, Ill., and the American Foundry Equipment Company of New York. The new organization will be known as the Whiting Corporation and will maintain the same offices and manufacturing equipment. J. H. Whiting, former president of the Whiting Foundry Equipment Company, becomes chairman of the board and V. E. Minich, former president of the American Foundry Equipment Company, president. E. A. Rich, Jr., will be in charge of the plant at 2935 West Forty-seventh street, Chicago, and R. S. Buch in charge of the York, Pa., plant. The corporation plans to maintain and enlarge the former offices of the American Foundry Equipment Company at 366 Madison avenue, New York, as the eastern sales and export office.

William S. Noble, who has been appointed manager of the railroad department of the Standard Paint Company, with offices in New York and Chicago, as was announced in the September issue, was born at Danville, Ky. He began railway work in 1887 as secretary to the vice-president of the Lehigh Valley. He was later assistant in the president's office and from 1905 to 1909 was assistant to the president of the Seaboard Air Line, the Clinchfield Coal Corporation and the Carolina, Clinchfield & Ohio Railroad at New York. He then was appointed president's assistant with the Lehigh Coal & Navigation Company, Philadelphia, and in 1914 entered the service of the Standard Paint Company, New York, in its railroad department. He subsequently served as western representative, from which position he was recently promoted to manager of the railroad department of the same company.

The Titan Steel Corporation has been organized with headquarters at Newark, N. J. It has acquired the plant of the Hewitt Steel Corporation and will enlarge and re-equip the plant for maximum production, with an initial payroll of 1,500 men. The plant in question was conducted during the war for the manufacture of steel shells. Before the war it was owned by the Titan Steel Castings Company, but at the outbreak of hostilities was acquired by the Hewitt Steel Corporation for the making of steel shell castings. It is now being re-equipped for the economical production of railroad specialties. The new company has also acquired by purchase approximately two-thirds of the capital stock of the Crown Castings Company, a holding company for patent rights and privileges for the manufacture of a truck and body bolster for railroad cars. E. H. Benners, president of the holding company and patentee of the truck and bolster, is vice-president of the Titan Steel Corporation. The Titan thus obtains the use of these patents and also one for the Benners side frame, which Mr. Benners holds. H. H. Hewitt, president of the Hewitt Steel Corporation, is a director of the new company, which also has acquired the manufacturing rights of the Hewitt car trucks and journal boxes. The officers of the company are as follows: R. E. Jennings, Sr., chairman of the board; R. E. Jennings, 2nd, president; S. A. Benners, vice-president; E. H. Benners, vice-president in charge of sales; E. E. Ledogar, treasurer, and R. J. Gill, secretary.

TRADE PUBLICATIONS

Price List.—The Poole Engineering & Machine Company, Baltimore, Md., has issued a new price list covering their various machines and equipment.

Multi-Cuttings.—The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio, has issued a 34-page booklet descriptive of their new semi-automatic lathe.

Murray Steam Power Plants.—Various engines, boilers, compressors, etc., are described and illustrated in catalogue No. 85, issued by the Murray Iron Works Company, Burlington, Ia.

Keller Pneumatic Tools.—A catalogue has been issued by the Keller Pneumatic Tool Company, Grand Haven, Mich., illustrating and describing their complete line of pneumatic tools.

Punches and Shears.—The Buffalo Forge Company, Buffalo, N. Y., has issued a 64-page catalogue illustrating and describing in detail their complete line of "Armor-Plate" punches and shears, bar, angle and tool cutters, etc.

Machine Molded Gears.—The Poole Engineering & Machine Company, Baltimore, Md., has issued a new catalogue describing machine-molded gears which they have arranged according to pitch, the prime factor in determining the strength of all gears.

The Locomotive Booster.—The Franklin Railway Supply Company, Inc., New York, has issued bulletin No. 975, describing the operation and control of the locomotive booster. Two charts show the relative increase in power by the application of the booster.

Canton Alligator Shears.—The Canton Foundry & Machine Company, Canton, Ohio, has issued a 23-page catalogue illustrating and describing "Canton" semi-steel shears, built in various styles and sizes, for cutting from 1-in. square to 3-in. square, inclusive.

Boilermakers' Tools.—The line of railway and boilermakers' supplies manufactured by the Lovejoy Tool Company, Chicago, is listed and briefly described in catalogue No. 10, containing 32 pages, illustrated. The line includes ratchets, drilling posts, punches and dies, expanders, flue cutters, pneumatic hammers, rivet forges and ball bearing jacks for railroad use.

Chain Blocks.—The Machine Shop issue of Hoisting Hints, published by the Yale & Towne Manufacturing Company, Stamford, Conn., contains a number of illustrations of Yale spur gear chain blocks handling heavy lifting operations in machine shops of many industries. These hoists are made in 17 sizes, with capacities ranging from ¼ to 40 tons, the booklet containing prices and specifications.

Radiagraph Cutting Torch.—The Davis-Bournonville Company, Jersey City, N. J., has issued a bulletin describing the No. 1A Radiagraph. This is a portable, mechanically operated cutting torch for cutting and beveling plate and structural steel. It cuts to straight and circular lines and when the torch is set at an angle bevels the edges of boiler plates. The bulletin shows some characteristic cutting done with it.

Forging Presses.—Bulletin No. 19, containing 24 pages, has been prepared for distribution by the Morgan Engineering Company, Alliance, Ohio, describing briefly the steam hydraulic forging presses built by this company, which consist of single frame types built in sizes from 150 to 500 tons capacity and four-column types up to 12,000 tons capacity. A general arrangement drawing of a typical modern forging shop is included in the bulletin.

Lateral Motion Driving Box.—Means for increasing the capacity of narrow-gage locomotives by the use of the Franklin lateral motion driving box and the Economy engine truck are described in bulletin 77, a four-page pamphlet issued by the Franklin Railway Supply Company, New York. These devices permit the use of an extra pair of driving wheels, with a corresponding increase in the tractive power of the locomotive. A line drawing shows the arrangement of the box and flexible side rods.

Instruction Book for Welders.—A new edition of the Eveready instruction book distributed by the Oxweld Acetylene Com-

pany, Chicago, is a comprehensive treatise on every-day oxy-acetylene welding and cutting. It is a compact reference book, containing 55 pages, 5 in. by 8 in., illustrated. Practical information on modern practices in welding and cutting is presented in a manner so that it can be easily grasped by the beginner, at the same time being valuable to the experienced welder and cutter.

Hammers.—A Captain of Industry is the title of a booklet published by the David Maydole Hammer Company, Norwich, N. Y. It contains a brief story of the life of David Maydole, the inventor of the adz-eye hammer, written by James Parton. In addition it includes a catalogue of the principal varieties of hammers made by the company and an amount of useful information for mechanics, which has been compiled mostly in tabular form, showing the weights and specific gravity of materials of various kinds, speeds of wheels and drills, rules for calculating measurements, etc.

Carbon Dioxide Recorder.—Bulletin No. 111 describing the style "U" Uehling carbon dioxide recording equipment has been issued by the Uehling Instrument Company, New York. This new design is built in single and multiple unit forms. The bulletin shows the principle of operation involved and explains the speedy action resulting from a new form of aspirator. Absence of chemical solutions, simplicity, and an auxiliary boiler front CO_2 indicator to guide the firemen, are explained as additional advantages. The recorder itself installed in the chief engineer's office makes a continuous record of CO_2 in the flue gases.

Bolt, Nut and Rivet Machinery.—A complete line of equipment for the manufacture of bolts and nuts is described in catalogue No. 20, issued by the Acme Machinery Company, Cleveland, Ohio. The machines include single and multiple bolt cutters with or without power feed and lead screws, special staybolt cutters, bolt pointers, nut tappers, nut burring machines, nut machines, bolt machines and upsetting and forging machines. The Acme die head manufactured by this company is also described and instructions are given for making or recutting dies. A set of tables of data pertaining to screw threads, bolts, nuts and rivets is included.

Bearings and Their Lubrication.—The Vacuum Oil Company, New York, has published a 32-page pamphlet which contains an extended discussion of the lubrication of various forms of bearings. The subject is introduced by illustrating and describing the more common forms of bearings used on various types of machinery. This is followed by a brief description of the usual method of applying the lubrication either directly or through distributing systems. Space is also given to the general discussion of lubrication in relation to the quality of oil; and the latter part of the publication is devoted to considerations affecting the selection of oil for any given purpose.

Welding Torches.—The Air Reduction Sales Company, New York, has issued a catalogue describing its new line of Airco "A" and "B" welding torches. The booklet has been made as complete as possible in order to give a clear understanding of the principles of torch operation involved in the construction of the Airco apparatus and their relation to good welding. The catalogue is well illustrated with half-tone reproductions of the full line of torches, angles of heads, tips, etc. Tables are given showing the thicknesses of metal that can be welded.

Steam Tables for Condenser Work.—The Wheeler Condenser & Engineering Company, Carteret, N. J., has published the fifth edition of its handbook of steam tables. The booklet is of convenient size and is illustrated. It gives the properties of saturated steam from 29.8 in. vacuum to atmospheric pressure in increments of tenths of an inch, with pressures below atmosphere expressed in inches of mercury referred to a 30-in. barometer. A complete table is also given of the properties of saturated steam above atmospheric pressure, with constants and tables for correcting vacuum column and barometer readings, such as thermal expansion of mercury, relative expansion of mercury and brass scale, etc.

Thermit Pipe Welding. The Metal & Thermit Corporation, New York, has issued the third edition of its thermit pipe welding pamphlet, No. 16. In the new edition the subject of thermit pipe welding has been revised and brought up to date. The making of thermit pipe welds is described in detail. The pamphlet also contains reports on successful tensile strength and vibration tests of thermit welds conducted by Stevens Institute, and a chart showing the comparatively low cost of a thermit welded pipe as compared with the cost of installing compression flanges with bolts and gaskets. The new edition also contains an account of a 10-year pipe test during which 700 ft. of 4-in. thermit welded pipe was constantly subjected to a hydraulic pressure of 1,500 lb. per sq. in., without requiring any attention.

Automatic Connectors.—A Performance Record of the American Automatic Connector, a booklet of 16 pages published by the American Automatic Connector Company, Cleveland, Ohio, presents the results that have been accomplished through the use of this equipment on 24 steel and 76 wooden hopper ore cars, 20 passenger cars and nine locomotives on the Copper Range Railroad. These connectors were installed more than a year ago and the trains were operated in what is possibly the worst snow region on this continent. An accurate record was kept by the railroad company of the cost of maintenance, the cause for each part renewed was determined and the results obtained through the use of the connectors were carefully analyzed. These have now been published in the booklet mentioned.

Greetings From the Texas Company.—A small booklet entitled "Howdy," was issued by the Texas Company, New York, to delegates attending the American Railroad Association convention, at Atlantic City. The booklet acquainted convention delegates with some interesting facts regarding the Texas Company. A discussion of railroad lubrication was given by George L. Noble, vice-president and general manager of the railroad sales department and conditions in the New York and Chicago fields were described by the respective department managers. Attention was called to the provision in some localities for spray oiling the rails in order to prevent corrosion and rust, using a specially designed car for this purpose. The last few pages of the booklet give a brief but interesting account of the activities of the Texas Company, outlining the fields covered by the different departments.

Stationary Boilers.—An interesting and well-illustrated 86-page catalogue, entitled Boiler Logic, has been issued by the Heine Safety Boiler Company, St. Louis, Mo. It contains a large amount of valuable information regarding boiler design, such as proper mixture of the gases, heat transmission by radiation, by convection and by transmission through the tubes to the water. Practical methods of baffling water tube boilers are described, with emphasis laid on flexibility of design, prevention of leakage, active and inactive surfaces, and ease of cleaning. Illustrations and descriptions are given of Heine boilers arranged for hand firing with bituminous or anthracite coal. Various kinds of stokers, including chain grate, side feed and underfeed stokers, are described. The catalogue illustrates different arrangements for burning fuels, including oil, shavings, bagasse and gas. Several pages are devoted to the overloading of boilers and a chart shows the relation between boiler load and excess of flue gas temperature over steam temperature. The last part takes up the design, construction and methods of shipping of Heine boilers.

Instruction Book for Grinding Machine.—The Heald Machine Company, Worcester, Mass., has issued a new instruction book explaining the operation and adjustment of the Heald No. 60 cylinder grinding machine, which contains a number of new features. It includes diagrams of floor plans, fan layouts, etc., making it unnecessary to use blueprints, and the instructions include not only those for adjusting the machine, but also for setting up. There is also a section on the selection of the proper grinding wheels. Wet and dry grinding is also taken up, as well as speeds and feeds and the various size arms which the company is in a position to furnish. At the back of the book is a section devoted to repair parts. In it, instead of the usual long list of names and numbers of the various parts and photographs of them, there are a number of line drawings, the first one being of the entire machine, which is termed the master chart. When a part is broken the operator, who has the machine in front of him and knows the location from which the part came, can turn to the chart designated on the master chart, which will show that particular section or unit of the machine and the part number he desires. This number, together with the serial number of the machine, will make it possible to furnish the exact piece required and guarantee interchangeability. The book contains 80 pages, 6 in. by 9 in., and is known as bulletin 501A.

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Systematizing Management in Railroad Shops

The systematic analysis of shop operations is a fairly recent development. It is an inevitable result of the increase in the size of individual plants which made it impossible for the supervisory officers to gain correct and definite information regarding the operation of the properties by personal observation. In many manufacturing plants the operations are few in number. This has facilitated the keeping of detailed records and has led to the introduction of time studies of the individual operations. At present, time studies and detailed records are the most important features of investigations of production in industry. Due to the diversity of the work in railroad shops, the introduction of these same methods involves an enormous amount of clerical work and for that reason many railroad shop men have contended that so-called scientific management methods could not be successfully used.

The argument against systematized management in railroad shops is based on objections to the methods used and not to the object to be attained. The records are the means to an end and are only useful for the results secured. Railroad shop executives who are trying to get increased output should recognize that systematic management methods have proved a great aid to industrial plants and should likewise be beneficial in railroad shops. There is no necessity for adopting the identical system that is used in industries, but by instituting a series of records that will check the progress of the work and insure that the various departments operate as a unit, troublesome delays can be avoided. The foremen could be relieved of a mass of routine duties, thus enabling them to give more time to developing improved methods and increasing the efficiency of their departments. Where no follow-up system is used in the shop, it will generally be found that the foremen spend a large part of their time trying to expedite the individual jobs. They have no means of knowing where the parts for the next locomotive that is due out have been delayed, why the storehouse has not delivered certain material, or any of the multitude of trivial matters that hold up production.

Most railroad shops are too large to function properly without some aids to management. Just how comprehensive a system is needed for a given shop depends on the size of the plant and the local conditions. At any rate, the time has come when railroad men should recognize that systematic management is needed and should attempt to apply the principles worked out in industry to the different conditions existing in railroad shops. Are you using a shop scheduling system?

Breaking Operating Records

The effect of the campaign of the Association of Railway Executives to secure improved operation of the railroads is quite evident in the records recently published by the American Railroad Association and the Interstate Commerce Commission. Statistics of the Car Service Division of the A. R. A. show that in the week ending October 9, 1,009,787 freight cars were loaded, a record that has been exceeded but once. This is the first time this year that freight car loading has passed the million mark although for several weeks the figures have been in excess of the loadings for the corresponding weeks in 1919 and 1918.

Operating statistics for the month of July show that the railroads during that month handled 15.2 per cent more freight than in July, 1919. In the first seven months of 1920 the number of tons of freight hauled one mile was 248,-999,000,000 in spite of the handicap of the outlaw strikes. This is an increase of 17.1 per cent as compared with the first seven months of 1919 and also represents a greater volume of traffic than has ever before been handled by the railroads in the first seven months of the year. In July of this year the average tons of freight per car was 29.7 as com-

pared with 28 in 1919. The average mileage per freight car per day was 26.2 as against 24.1 last year.

While operating statistics for the later months are not available, the records of car loading already mentioned indicate that the performance is steadily improving. This is further shown by the fact that the accumulation of loaded cars in terminals awaiting movement, which was almost 100,000 on March 1 when the roads were returned, was reduced to 41,135 on October 8. As nearly 18,000 of these cars were being held at ports for ships, it is no exaggeration to state that congestions have ceased to exist.

The general freight car situation is also improving as shown by the fact that the car shortage for the week ending October 1 shows a reduction of 9,000 cars as compared with the previous week. Cars are being returned to the owners and on October 1, 30 per cent of the cars were on home lines, a gain of 2 per cent over September 1 and of 8.1 per cent over March 1. To offset these circumstances, however, the percentage of bad-order cars shows a slight increase from 7.0 per cent in June, 1920 to 7.2 per cent in July. Conditions are better than in July, 1919, when the percentage of bad-order cars was 8.7, but this was almost a high record and there is urgent need for more attention to car repairs in order that the unserviceable equipment may be brought down to the normal value of four per cent.

This record is splendid, but it can be still further improved by enthusiastic and intelligent co-operation of all of the departments on the railroads and of every man in each department. Mechanical department forces in particular can be a big factor in improved operation.

Accident Investigation Discloses Disregard of I.C.C. Rules

The chief inspector of locomotive boilers has recently reported to the Interstate Commerce Commission a crown sheet failure on a passenger train which resulted in the death of the engineer and fireman. The circumstances are somewhat unusual in that the investigation disclosed several flagrant violations of the provisions of inspection rules. The accident occurred on a Pacific type locomotive drawing a passenger train and while running at a speed of about 45 miles an hour. The crown sheet failed, permitting steam and water to enter the cab and resulting in fatal injuries to both members of the crew. The locomotive was built in 1913 and had a straight top radial stayed boiler supported by 1⅛ in. stays, spaced 4 in. by 4 in. The crown sheet pocketed to a depth of 4 in. on the right side. In the pocketed area there were 37 broken bolts, 12 which were not broken which the sheet pulled off. Numerous defective stays were found outside the pocketed area. No evidence of overheating or strain was found, but after the pocketed section of the plate was cut out, an examination of the broken bolts showed that the ends were coated with considerable scale. From the appearance of the rest of the boiler, it was believed that these stays were broken some time previous to the last monthly inspection, which was made 20 days prior to the accident.

Investigation disclosed that on the previous trip, the safety valves did not relieve the pressure and it went as high as 250 lb. Nevertheless the inspectors did not believe that this was a factor in causing the accident as the stresses on the crown stays would have been well within the allowable limit.

The inspector who certified to the condition of the boiler at the last monthly inspection admitted that he did not perform the work called for on the report and that the locomotive was not fired up although the report stated that the safety valves were set on that day. It was also brought out that in setting the safety valves on the day of the accident a second steam gage, as required by law, was not used.

In commenting on the accident, the chief inspector calls attention to the laxity of the mechanical department officers in assigning men to make inspections without knowing that they were capable of performing such work and for not supervising the work to see that the requirements of the rules were complied with. Attention is directed to the fact that the fatalities might have been avoided had the locomotive been equipped with automatic firedoors, and the use of tell-tale holes in all crown stays and staybolts, regardless of their length, is recommended.

Better Freight Cars Needed

The railroads, spurred on by the necessity of moving an unprecedented amount of freight in order to prevent a heavy curtailment of production, have made a remarkable record during the past few months. The goals which were established by the Association of Railway Executives included an average movement of each loaded freight car of 30 miles per day, with an average loading of 30 tons. During July the roads averaged 26 miles per car per day. During that month 12 of the large roads exceeded the standard for car loading and 15 roads attained an average of over 30 miles per car day. The splendid service which has been done by the car service committees and the car service organization has made it possible to break up the congestions at different points and to secure a more normal freight car movement.

One thing is interfering greatly with getting a better movement, and that is that so many of the freight cars are in poor condition. Some of them are too light and should have been retired from service long ago, and a great many others, if they are to remain in service, must be rebuilt and be very considerably reinforced. It is poor policy to try to continue to operate cars which cannot stand up under service. It means that heavy trains are continually being delayed because of defective cars and in many cases these breakdowns have wrecked good cars and have damaged or destroyed considerable amounts of freight. The mechanical department should use every influence to get the cars into good operating condition, or to see that they are set aside if they are not fit.

Use of Wired and Safety Glass

So large a proportion of the injuries sustained as a result of the bomb explosion which occurred recently in Wall street were directly due to broken glass falling from the shattered windows, that there was much speculation as to the extent to which these injuries would have been lessened had the use of wire glass been more general. Every accident from a broken windshield resulting from even slight automobile mishaps invites similar consideration in favor of the use of safety glass. While broken glass does not figure prominently in railroad accidents, the menace is always present.

With the wide use of wire glass and the improvement that has more recently been effected in the construction of safety glass, there is no reason why the special properties possessed by both of these materials should not be more generally taken advantage of in car and locomotive use as well as in shops, stations and office buildings.

Safety glass consists of two layers of ordinary glass cemented together, so that when struck a sharp blow it will not shatter into many flying fragments, although it may be badly cracked. When first manufactured safety glass did not have altogether satisfactory visibility, but this has been remedied and its use for automobile windshields has become popular. The same arguments in favor of its use in an automobile windshield should apply to its use in a locomotive cab; if you are willing to pay the extra price for this form of protection in your automobile, would it not be consistent to place the same glass in the locomotive cab? The use of any material that promises additional protection to employees is something to which mechanical engineers should always give serious consideration.

DO YOU KNOW YOUR MEN?

William S. Wollner, general safety, fire prevention and welfare agent of the Northwestern Pacific, in an address before the October meeting of the New York Railroad Club on The Human Element in Railroading, drew a sharp contrast between the critical attention which is given to the selection and use of materials on the railroads and the comparative indifference which is paid to the selection and use of a far more vital factor—the men. Is it not true that this lack of appreciation of the necessity for using special skill and scientific methods in directing the human element is at the bottom of most of the labor difficulties which beset us?

Training the Foremen

A large part of the leadership on the railroads, even outside of those departments which have to do with civil, mechanical and electrical engineering problems, is in the hands of technically educated men. Young men who enter engineering courses in our colleges look forward, most of them, to the time when they will be advanced to executive positions and will have considerable forces of men working under their direction, and yet, even today, how many of our engineering courses give any adequate amount of attention to problems affecting the utilization and direction of human energy? It is true that the technical graduate today is better favored in these respects than those of us who were graduated several years ago, but even at that, in most cases, he is little better fitted in this respect when he is graduated than he is of using good English and sound logic in making up an engineering report.

On the other hand, how much real coaching or training does a foreman receive in the supervising of men when he is promoted from the ranks? He may have the highest sort of ability in this respect lying dormant, but of what use is this unless he knows how to utilize it? A cutting tool may be made of the finest kind of steel, but if it is not properly sharpened for the work which it is to do, it is inefficient and oft-times useless.

A few industries have awakened to the vital necessity of educating their foremen and subordinate officers in the art of training men and directing their work and they are getting big returns from an almost insignificant expenditure. Ordinarily a foreman or boss in railroad service is taken from the ranks and is literally thrown at the job. In some cases hs fails miserably when he could have made good under intelligent direction. In other cases he stumbles along and manages to get by, but like Topsy, he "just grows up" to the job and the limited education that he receives from bitter experience costs his company heavily. In a few cases the new foreman has a rare ability as a director of men and makes good from the start, but even these men would do better and go further if aided by a comprehensive and intensive course of study. An ordinary mechanic serves four years as an apprentice to perfect himself in handling a few tools and doing a limited number of mechanical jobs. On the other hand, a foreman who must direct men, the biggest and most complex factor in production, receives no special training. Is it not logical that when a man is selected for promotion he should at least receive a course of training in the art of handling men which will take as long a time as learning how to operate a typewriting or calculating machine, and yet, whoever heard of this being done on a railroad?

If the individual railroads cannot see their way clear to provide proper training courses for such men in the various departments, why not have the roads combine into groups? Or possibly the American Railway Association could arrange to provide the necessary courses and training schools. And why should the American Railway Association not do this? At present it is concentrating all its energies on securing the best use of the present facilities, and yet, what course could the association take which would do so much in this direction as seeing that the supervising officers were all suitably instructed and equipped in the art of handling men?

Labor Turnover

In discussing Mr. Wollner's paper J. C. Clark, assistant to the general manager of the Oregon Short Line, directed attention to the great waste on the railroads because of the excessive labor turnover. The labor turnover is a symptom of a disease and in order to locate the cause and eliminate it a thorough and scientific analysis must be made of the reasons why men leave the service. Incidentally, if the railroads realized the great expense to which they are put in breaking in new men they would be inspired to locate the weak spots in the organization and strengthen them, even at a very considerable cost. Many industries have thoroughly analyzed the labor turnover with excellent results. Railroads are not very different from industries in general and they should take advantage of what has been done in other fields. But where are the men of vision in the railroad field who will take the initiative and not only make such studies, but follow them up and take advantage of them?

Master Workmen

The railroads have made remarkable progress in speeding up transportation and in getting the maximum use out of the present limited facilities. They will, however, have to do even more if the prosperity of the country is to go forward. If the roads do not get more use from the present equipment some of our people will have to undergo much suffering. In the last analysis, however, all of the people will feel the effects. Inefficient workmen, or skilled workmen who deliberately restrict production, may feel that they are justified in their position and that they are taking it out of the bosses or the stockholders. Under modern industrial conditions, however, we have grown so interdependent that one part of our people cannot be hurt without the entire population being affected.

The New York Tribune has just published a copyrighted series of articles by Marshall Olds on The High Cost of Strikes. The following paragraph is significant:

"American public sympathy has always been, naturally and openly, on the side of labor, because its struggles were so frequently against the same big industrial 'robber barons' which the public itself was fighting and because in general in its fight with capital, labor seemed to be the under dog. But labor's overconfident, often almost mad, insistence in flaunting its fundamental doctrine of class rights, its increasingly ruthless and open infringement of the most basic and important rights of all the people to be fed and warmed and clothed, in order that some small group of the labor class may be able to draw full pay for working three days a week or in order to put one group of men instead of another group into union power, is an open challenge as to whether America is to go back to the class and group government of the Middle Ages for the benefit of some of the people, or is to stay American for the benefit of all Americans."

Wise, intelligent supervision, patient effort and simple educational measures will do much to bring those elements that are abusing their power to their senses. Fortunately the American railway workers are above the average of industrial workers in this country. We will never get anywhere, however, if those who direct them are not big enough and sufficiently well trained to know how to deal with them properly, and wisely direct their energies. If we are to have master workmen we must have expert and master foremen and executives, and the higher executives especially must have a keen and broad appreciation of the importance of the human element in the organization.

COMMUNICATIONS

ASSIGNING LOCOMOTIVES

Philadelphia, Pa.

To the Editor:

The proverbial man from Mars, if he were to observe our railroads, could not fail to wonder at the assignment of engines to trains. Often locomotives are distributed seemingly as though any engine would fit any train. When the project for standard engines was under way during the war, one of the chief arguments against them was that they would not fit any particular set of operating conditions. But could the assignment of these engines to any particular division be more out of place than the assignment of engines to some trains on which they are regularly placed? I have seen within a half hour on the same piece of track a heavy Pacific engine go by hauling a four car passenger train and a light Atlantic engine loaded down with a full tonnage freight train, about twenty box cars. The Atlantic engine could easily have handled the passenger train—it had in times gone by—and as a freight engine, the Pacific could have handled practically the same tonnage as the Consolidations and done it faster.

Not many hours before writing these lines, I saw one of the finest Pacific engines in the country hauling a little local train into the station, a train any eight-wheeler could have handled. I do not believe that this road is short of eight-wheelers, it always has plenty around the repair shop farm; but it hauls plenty of little local trains with Atlantic and Pacific engines. Frequently Mogul engines are used on the same service, and I have become hardened to the sight of a Consolidation engine on passenger trains. There is even one local passenger train that I can expect to see with a Mikado.

Why should a little engine go out hauling a big train and right behind it come a little train with a big engine? Why should freight train after freight train pass, all with about the same tonnage, but with all sizes of engines? Why should a thirty-five car train have one engine and a forty-car train be double-headed? Why should some divisions have all small engines when some large ones could be used, and others have all large engines when smaller ones could be used to advantage on some of the trains?

Why should not the responsibility for the assignment of engines be placed squarely on somebody's shoulders, he to look after the location of the present power and its general assignment to trains and to have the further duty of continually investigating operating conditions with a view to developing new sizes of power to meet the requirements? He should aim as far as possible to have the right engine on the right train, shifting the engines from roundhouse to roundhouse until the best results are obtained.

It is a difficult problem, and, in general, at present is nobody's business. The superintendent of motive power has too much to do. The master mechanics are glad to keep the engines in running order. The road foreman of engines is glad to keep them going after they are turned over to the operating department. He has his hands full to keep the engines in order and scrape up an engine now and then when they get real scarce. The roundhouse foreman often is satisfied if he has any engine at all for each train. I have seen a little eight-wheel engine weighing not over 100,000 lb. go out with a seven-car express train that would have taxed the capacity of an Atlantic of twice the size. Why? It was the only engine of that division that happened to be in the house. I have seen the roundhouse foreman wonder whether any passenger engine would come in that was fit to send out on the limited in the morning, or whether he would in the end have to use the best freight engine in the house. As far as the operating department is concerned, any engine that is big enough to haul the train will do.

It is very bad policy not to distribute the motive power to the best advantage. It costs extra money to handle little trains with big engines; it may cost extra money to handle big trains with little engines, and it is certainly unsatisfactory to all of us who have been late because the engine could not handle the train. Here lies an opportunity for increased efficiency! Why should not the job be given to a particular officer, who would have to know the whole road, the weight of trains, profile, condition of track, the characteristics and condition of each engine on the road, the train schedule, and all the other things that affect the problem, and from these things plan the distribution of motive power, keeping an eye on the order in which the engines go into the shop so as not to get stuck at any time for a particular class of engine and, in general, see that the right engine is always available and used so that we will not be treated to the spectacle of 150,000 lb. Consolidations and 320,000 lb. Mikados hauling the same weight train over the same track.

Geo. N. Clouser.

SHOP LABOR CONDITIONS

New York, N. Y.

To the Editor:

Labor conditions generally are improving slowly. There is still much to be done before getting back to the conditions that existed before the war. The movement now on foot by the labor leaders to nationalize the railroads through National Agreements and National Boards of Adjustment is of vital importance to the public.

If this movement goes through the present indications of there being a betterment will be reversed. Much depends on just what is done in the next few months. The time is opportune for shaking off a big per cent of the things that hamper improving conditions.

Most shops have on their hands a lot of mechanics with little or no skill; men who were employed during the war period when good men were unobtainable. These partially skilled men who have not showed any aptitude for improvement must be weeded out and good men put in their places. This move cannot be made unless there is either a marked modification made in the National Agreement on seniority rights or an arbitrary stand taken to disregard entirely all the rules and working agreements that were put in force by the Railroad Administration during government control.

Certainly the spirit of the Transportation Act was to restore each individual road to an individual operating unit so that they might deal with their own men independently, without being hampered in any manner by political influence. National Boards of Adjustment will mean a continuation in a marked degree of the conditions that built up step by step the inefficient machine that must now be rebuilt in i[illegible] entirety. The public has a right to an efficient transpor[illegible] tion machine. The roads gave them one before the [illegible] period; they can do it again if unhampered and again p[illegible] in the position of individual units so that each one's la[illegible] problems may be worked out and solved by the local officia[illegible]

The right to re-establish either the piece work system, bonus or merit system is of paramount importance. Th[illegible] National Agreement method of paying all men alike regard less of their skill or production capacity is entirely wrong it can only lead to one thing—inefficiency. This octopu[illegible] must be shaken off. The good workmen in the railroad shops never favored this method of rate fixing and do not favor it now. There are now lots of men looking for employment. The time is ripe for something to be done; the start must eventually be made. Why postpone the inevitable?

F. Oreman.

Mountain Type Locomotives for the New Haven

Equipment Includes Feed Water Heaters and Provision for Future Application of the Booster

The New York, New Haven & Hartford has purchased 30 Mountain type locomotives from the American Locomotive Company following closely in design the U. S. R. A. standard light Mountain type locomotives delivered to that railroad by the same builders during federal control. The new locomotives were built at the Schenectady works of the American Locomotive Company. The selection of this type for freight service is particularly significant in view of the fact that the railroad has also had experience with Mikado and Santa Fe type locomotives of recent design.

The construction of a large, well-designed classification yard at Cedar Hill, near New Haven, Conn., which was described in the July 30, 1920, issue of the Railway Age has placed the New Haven in a better position to utilize heavy power in freight service. It has always been a difficult matter on the New Haven to assemble heavy tonnage trains regularly for through movement on account of the character of the territory served and it may be possible that the potential tonnage rating of the Santa Fe type locomotives would be in excess of the practical limitations on this section on the line. On the other hand, the Mountain type should be able to demonstrate sustained speed with full tonnage trains in excess of the Mikado type locomotives.

The new Mountain type locomotive will operate mainly in through service between New Haven and Providence, a distance of approximately 110 miles. As this portion of the railroad is a two track line over which moves a large portion of the fast passenger service between New York and Boston, the necessity for a locomotive that can handle these freight trains at sustained speed is apparent.

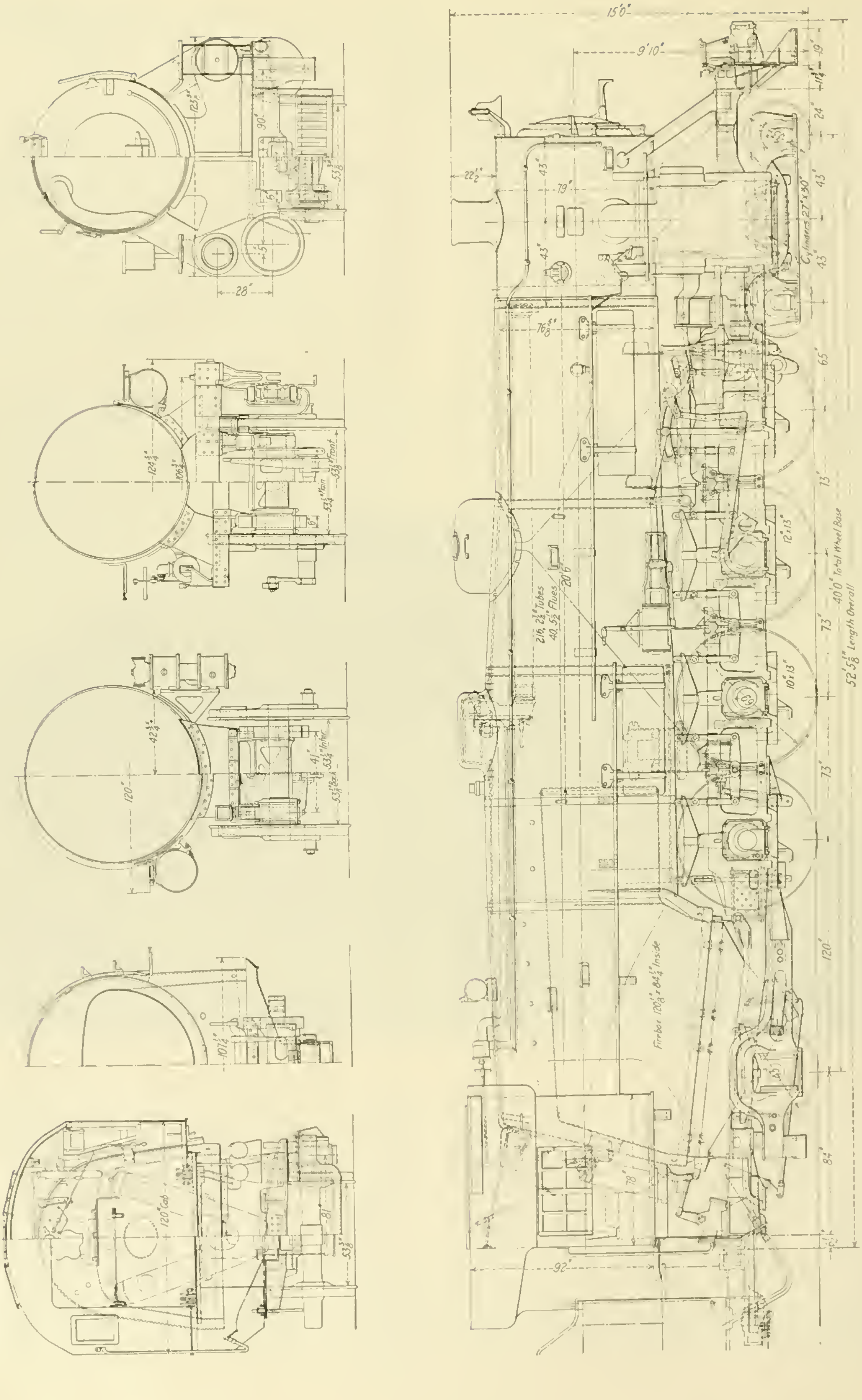
Mountain Type Locomotive for Fast Freight Service

Performance Characteristics

The light Mountain type was the last of the standard designs to be prepared by the Railroad Administration but the first of these locomotives completed by the American Locomotive Company was consigned to the New Haven. The performance of these first Mountain type locomotives has been generally satisfactory and the new locomotives do not differ from them in any marked degree except for the addition of several important specialties designed to increase the efficiency and capacity of the new locomotives.

The locomotives will exert a maximum tractive effort of 53,900 lb. The line over which these locomotives will operate is along the shore of Long Island Sound and is practically level except for a few short breaks with a maximum of 0.6 per cent for a short distance. As the tonnage handled by these locomotives will be approximately 3,000 tons, they should be able to handle a large volume of through freight in conjunction with the heavy passenger traffic.

Based on the performance of the earlier Mountain type locomotives it is anticipated that the new locomotives will be



Elevation and Sections of N. Y. N. H. and H. Mountain Type Locomotive

able to operate on an average monthly fuel consumption of not to exceed 135 lb. of coal per 1,000 ton-miles. The locomotives will, of course, make a very much better fuel performance between terminals and although these locomotives have been in service only a short time, they have already shown remarkable economy in the use of fuel. A close record is being kept of their performance and three of the locomotives recently effected an average record of 62 lb. of coal per 1,000 ton-miles between terminals with an average train load of 2,968 tons. One of these locomotives was equipped with a feedwater heater which is part of the regular equipment applied to five of these locomotives.

Changes in the Standard Design

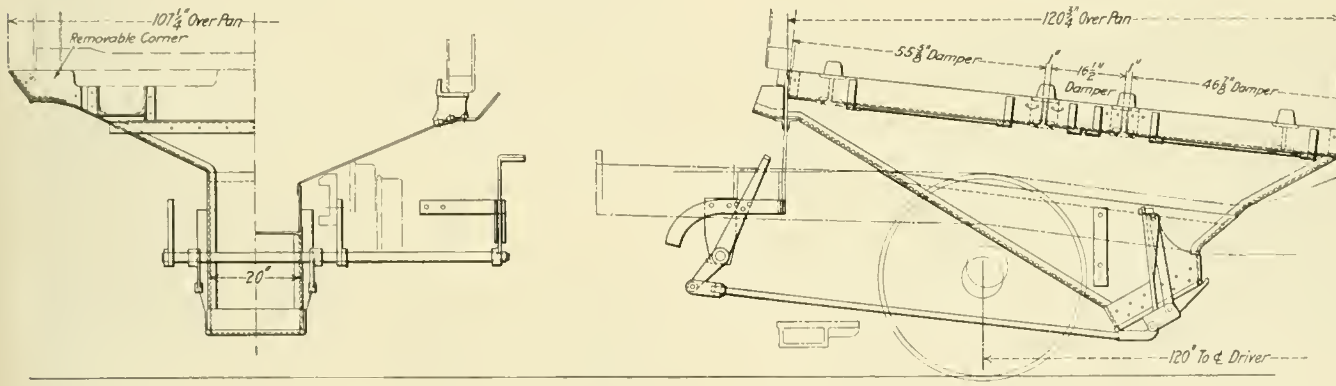
The general dimensions of the new locomotives are practically identical with the U. S. R. A. standard light Mountain type locomotives described in the July, 1919, issue of the *Railway Mechanical Engineer*. The boiler and firebox are the same with the exception of a small increase in the number of staybolts applied and an increase in superheater heating surface from 966 sq. ft. to 1,009 sq. ft. The engine truck presents the first noticeable departure; this is of the constant resistance type with Commonwealth cast steel truck

ble effort must be made to obtain the maximum service from every pound of coal. Feedwater heaters of the exhaust steam type appear to offer possibilities for a very large fuel saving particularly on the long level pulls where the locomotives will be continuously exhausting steam.

Future Application of Booster

The application of a booster to the trailing truck of these locomotives should materially increase the maximum tractive effort available for starting trains and might eliminate the services of a pusher used in assisting the trains over Branford Hill, a short distance out of the Cedar Hill yard. The railroad has probably had this in mind in providing for the future application of the booster to the extent of equipping all of the locomotives with trailing truck axles so designed that booster gears can be applied without necessitating new axles. The trailing truck is of the Woodward-Commonwealth type and the trailing truck brake is also arranged for the possible future application of the booster.

The most interesting detail in this connection is the use of a single hopper ashpan. The base of the pan slopes forward to a single drop door in advance of the trailer truck axle. The purpose of this design was to facilitate the application



Single Dump Ash Pan Designed to Facilitate Booster Application

frame. Wheel dimensions are the same but the distribution of weight is changed as shown in the following table:

	Light Mountain type locomotive	
	New N. Y., N. H. & H.	U. S. R. A. standard
Total weight, lb.	328,500	327,000
Weight on drivers, lb.	229,000	224,500
Weight on engine truck, lb.	47,000	49,500
Weight on trailing truck, lb.	52,500	53,000

The important specialties applied to these locomotives include the following: Duplex stoker, Franklin firedoor, Franklin grate shaker, Radial buffer and Unit drawbar, Alco flexible staybolts (1773 applied), Chambers throttle valve (modified design), Lewis power reverse, and Southern valve gear.

The cylinders are cast with by-pass value chambers to permit the future application of the railroad company's standard by-pass valves.

Application of Feedwater Heater

The feedwater heater and feedwater pump is an important addition to these locomotives. The apparatus has been applied to five engines and the arrangement of the running board and air pumps on the left hand side of the remaining 25 locomotives is such as to facilitate the application of this device at a later date. The Locomotive Feedwater Heater Company's standard apparatus is used. This includes a type E-1 heater and a 6½ in. pump having a capacity of approximately 7,500 gal. an hour.

The railroad has adopted an open-minded attitude toward the application of feedwater heaters. The fuel problem is acute on the New Haven and it is realized that every possi-

of the booster, although it appears that a further change would have to be effected in the design in order to provide sufficient clearance for the booster mechanism.

Principal Dimensions

The principal dimensions and data for these locomotives are as follows:

General Data	
Construction number	62205—34
Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bituminous coal
Tractive effort	53,900 lb.
Weight in working order	328,500 lb.
Weight on drivers	229,000 lb.
Weight on leading truck	47,000 lb.
Weight on trailing truck	52,500 lb.
Weight of engine and tender in working order	511,000 lb.
Wheel base, driving	18 ft. 3 in.
Wheel base, total	40 ft. 0 in.
Wheel base, engine and tender	75 ft. 7½ in.
Ratios	
Weight on drivers ÷ tractive effort	4.25
Total weight ÷ tractive effort	6.1
Tractive effort × diam. drivers ÷ equivalent heating surface*	660
Equivalent heating surface* ÷ grate area	80.1
Firebox heating surface ÷ equivalent heating surface* per cent	6.2
Weight on drivers ÷ equivalent heating surface*	40.7
Total weight ÷ equivalent heating surface*	58.3
Volume both cylinders	19.9 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	283.2
Grate area ÷ vol. cylinders	3.5
Cylinders	
Kind	Simple
Diameter and stroke	27 in. by 30 in.
Valves	
Kind	Piston
Diameter	14 in.
Greatest travel	7 in.
Steam	1¼ in.
Exhaust clearance	3/16 in.
Lead	¼ in.

Wheels	
Driving diameter over tires	69 in.
Driving journals, main, diameter and length	12 in. by 13 in.
Driving journals, others, diameter and length	10 in. by 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ in. by 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	9 in. by 14 in.

Boiler	
Style	Conical, connected
Working pressure	200 lb. per sq. in.
Outside diameter of first ring	78 in.
Tubes, number and outside diameter	216—2¼ in.
Firebox, length and width	120⅛ in by 84¼ in.
Firebox plates, thickness	Tube and throat, ½ in.; others, ⅜ in.
Firebox, water space	Front, 6 in.; others, 5 in.
Flues, number and outside diameter	40—5½ in.
Tubes and flues, length	20 ft. 6 in.
Heating surface, tubes	2,597 sq. ft.
Heating surface, flues	1,176 sq. ft.
Heating surface, firebox, including arch tubes	348 sq. ft.
Heating surface, total	4,121 sq. ft.
Superheater heating surface	1,009 sq. ft.
Equivalent heating surface*	5,635 sq. ft.
Grate area	70.3

Tender	
Tank	Water leg
Frame	Cast steel
Weight	182,500 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	16 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

COMMITTEE APPOINTMENTS OF MECHANICAL DIVISION, A. R. A.

The American Railway Association has recently issued a list of the standing and special committees appointed by the General Committee to serve until June, 1921. The committees have been given alphabetical designations as well as names. Those committees having a number after the designating letter are considered a part of the committee whose letter they bear and the chairmen of such committees are expected to attend meetings of the main committee. A list of the committees and the chairmen is given below.

Standing Committees

A—Arbitration. T. H. Goodnow (Chairman), superintendent car department, Chicago & North Western, Chicago.

A-1—Prices for Labor and Material. A. E. Calkins (Chairman), superintendent rolling stock, New York Central, New York.

B—Arrangements. W. J. Tollerton (Chairman), general mechanical superintendent, Chicago, Rock Island & Pacific, Chicago.

C—Autogenous and Electric Welding. J. T. Wallis (Chairman), chief of motive power, Pennsylvania System, Philadelphia.

D—Car Construction. W. F. Kiesel, Jr. (Chairman), mechanical engineer, Pennsylvania System, Altoona, Pa.

D-1—Brake Shoe and Brake Beam Equipment. W. J. Bohan (Chairman), assistant general mechanical superintendent, Northern Pacific, St. Paul, Minn.

D-2—Couplers and Draft Gears. R. L. Kleine (Chairman), assistant chief of motive power, Pennsylvania System, Philadelphia.

D-3—Train Brake and Signal Equipment. T. L. Burton (Chairman), consulting air brake engineer, New York Central, New York.

E—Car Wheels. W. C. A. Henry (Chairman), general superintendent motive power, Pennsylvania System, St. Louis, Mo.

F—Committees. T. H. Goodnow (Chairman), superintendent car department, Chicago & North Western, Chicago.

G—Locomotive Construction. H. T. Bentley (Chairman), superintendent motive power and machinery, Chicago & North Western, Chicago.

G-1—Design and Maintenance of Locomotive Boilers. G. H. Emerson (Chairman), chief of motive power and equipment, Baltimore & Ohio, Baltimore, Md.

G-2—Feed Water Heaters for Locomotives. F. M. Waring (Chairman), engineer tests, Pennsylvania System, Altoona, Pa.

G-3—Fuel Economy and Smoke Prevention. William Schlafge (Chairman), mechanical manager, Erie, New York, N. Y.

G-4—Mechanical Stokers. M. A. Kinney (Chairman), superintendent motive power, Hocking Valley, Columbus, Ohio.

H—Loading Rules. R. L. Kleine (Chairman), assistant chief of motive power, Pennsylvania System, Philadelphia, Pa.

I—Manual. W. E. Dunham (Chairman), assistant superintendent motive power and machinery, Chicago & North Western, Chicago.

J—Nominating. F. W. Brazier (Chairman), assistant to general superintendent rolling stock, New York Central, New York.

K—Safety Appliances. C. E. Chambers (Chairman), superintendent motive power and equipment, Central Railroad of New Jersey, Jersey City, N. J.

L—Specifications and Tests for Materials. F. M. Waring (Chairman), engineer tests, Pennsylvania System, Altoona, Pa.

M—Subjects. Willard Kells (Chairman), general superintendent motive power, Atlantic Coast Line, Wilmington, N. C.

N—Tank Cars. A. W. Gibbs (Chairman), chief mechanical engineer, Pennsylvania System, Philadelphia, Pa.

Special Committees

O—Amalgamation of Other Mechanical Organizations with Section III-Mechanical, of the American Railroad Association. W. O. Thompson (chairman), general superintendent rolling stock, New York Central, Buffalo, N. Y.

P—Car Repair Shop Layouts. I. S. Downing (Chairman), general master car builder, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.

Q—Design, Maintenance and Operation of Electric Rolling Stock. G. C. Bishop (Chairman), superintendent motive power, Long Island railroad, Richmond Hill, N. Y.

R—Engine Terminals, Design and Operation. C. E. Fuller (Chairman), superintendent motive power and machinery, Union Pacific, Omaha, Neb.

S—Lateral Motion on Locomotives. Willard Kells (Chairman), general superintendent motive power, Atlantic Coast Line, Wilmington, N. C.

T—Locomotive Headlights and Classification Lamps. W. H. Flynn (Chairman), superintendent motive power, Michigan Central, Detroit, Mich.

U—Modernization of Stationary Boiler Plants. L. A. Richardson (Chairman), mechanical superintendent, Chicago, Rock Island & Pacific, Des Moines, Iowa.

V—Scheduling of Equipment Through Repair Shops. Henry Gardner (Chairman), corporate mechanical engineer, Baltimore & Ohio, Baltimore, Md.

W—Standard Blocking for Cradles of Car Dumping Machines. J. McMullen (Chairman), superintendent car department, Erie, New York, N. Y.

X—Standard Method of Packing Journal Boxes. C. J. Bodemer (Chairman), assistant superintendent machinery, Louisville & Nashville, Louisville, Ky.

Y—Train Lighting and Equipment. J. R. Sloan (Chairman), chief electrician, Pennsylvania System, Pittsburgh, Pa.

Z—Train Resistance and Tonnage Rating. O. P. Reese (Chairman), superintendent motive power, Pennsylvania System, Toledo, Ohio.

The Problems of the Supervising Officers*

Their Duties and Responsibilities Under Private Railroad Management; Organization of Foremen

BY SAMUEL O. DUNN

Editor, Railway Age and Vice-President Simmons-Boardman Publishing Co.

THE invitation of your president to talk to you made me anxious to avail myself of the opportunity to come here and meet you. I was much gratified when, in our conversation your president, Mr. O'Neill indicated he was familiar with the editorial policy which always has been followed by the Railway Age, the *Railway Mechanical Engineer*, and the other railway papers of which I am editor-in-chief, in the discussion of the problems of the railway supervising officer. It has been our uniform policy to urge upon the managements of the railways the wisdom of employing an adequate number of supervising officers in all departments, and of paying them salaries commensurate with their duties and responsibilities. As you know, the struggles between the railroad labor organizations and the railway companies have in the past frequently resulted in some conductors, locomotive engineers and other employees being paid wages exceeding the salaries of shop foremen, trainmasters, yardmasters and other officers having supervision over their work. In the editorial columns of our papers, we have contended that only in very exceptional cases could there be any justification for any employee in the ranks being paid higher wages than the supervising officers—that the efficiency of operation and justice to the supervising officers demanded that in almost every case the supervising officer's compensation should exceed, and substantially exceed, the wage of any of his subordinates. We took this position when the railways were under private operation. We took it when they were under government control. We have taken it since they have been returned to private operation.

In view of these facts, it has been a source of some gratification to me that immediately after the recent large advance in wages to employees was granted by the Railroad Labor Board the Association of Railway Executives voluntarily took up the general question of the salaries of supervising officers and urged the managements of the individual lines promptly to revise them on a basis which would make them reasonable and fair as compared with the new wages to be paid to the employees. I do not know how many railway managements have followed this advice, but I have no hesitation in saying that it is advice which every railway management ought to follow.

The Position of Supervising Officers

The supervising officers of all classes, and in the mechanical, maintenance of way and transportation departments especially, are the points of contact between the railway managements, on the one hand, and the employees, on the other. It is, under private ownership, the function of the management to determine the policies adopted in the development, maintenance and operation of the railways. It is the function of the supervising officers to see that the employees work in such a manner as efficiently to carry out these policies.

The position of supervising officers, under present conditions, is one of difficulty and delicacy. There is more or less uncertainty in the minds of many supervising officers in regard to their proper relations to the owners and managers, on the one side, and the employees, on the other. Naturally it is the desire of all supervising officers to make their own situation as favorable as practicable with respect both to conditions of employment and compensation. There is, unfortunately, a large amount of antagonism between the managements, on the one side, and the labor unions, on the other. Placed as they are between these two elements, many supervising officers question whether it is their duty and to their interest to identify themselves principally with the managements, on the one side, or the organized employees, on the other.

Should Supervisors Be Identified with the Unions?

I think we can agree that the fundamental need of all of us—the railway managements, supervising officers, employees and the public—is that the railways shall be adequately developed and shall be operated as efficiently as possible. I mean by adequately developed, that their facilities shall be sufficiently increased to enable them satisfactorily to handle all the traffic that the American people and American industries can produce and offer to them. By efficiently operated I mean, so operated that the very greatest practicable service will be obtained from every ton of material and fuel used, from every mile of track, every locomotive and every car, and that every officer and employee shall do the most and the best work he can consistent with having reasonable hours of work and maintaining himself in good health. The railways are one of the most important parts of our national machinery of production. The efficient operation of all our machinery of production is essential to increasing our production of the necessities, comforts and luxuries of life. An increased production of the necessities, comforts and luxuries of life is essential for the promotion of the welfare of all of us, and especially of the working classes themselves. The second point upon which I think we can agree is that we should adopt on our railways, and in our other industries, not only that system which will secure the greatest practicable production, but also that system which will secure the most equitable division of what is produced among all who participate in producing it.

But under what system of ownership and management of the railways and other industries will we secure the greatest efficiency in production, and the greatest equity in the division of what is produced? Upon this question there are the widest differences of opinion. With respect to the railways there are, on the one side, those who advocate private ownership and management, while, on the other side, there are those who advocate the Plumb plan. Whether supervising officers will decide that they ought to identify themselves with the managements of the railways as they have in the past, or associate themselves more or less with the employees in the disputes arising between the managements and the employees, doubtless will be determined largely by which system of railroad ownership and management they favor. It is not necessary for me to tell you that the railroad brotherhoods have made, and still are making, efforts to get supervising officers of all classes to aline themselves with the brotherhoods and adopt the ordinary union methods of dealing with the managements regarding their conditions

* From an address delivered at a meeting of the International Association of Railroad Supervisors of Mechanics, Milwaukee, Wis., September 22, 1920.

of employment and wages, and to support the Plumb plan of railroad ownership and management.

Importance of the Attitude of the Foremen

It is of great importance to the railway companies, and also to the supervising officers, that the supervising officers should decide wisely regarding the stand that they are going to take concerning the differences which arise between the railway managements and the employees. The managements of the railways cannot operate them efficiently under private ownership unless they can rely upon the supervising officers to carry out the policies of the managements thoroughly and to so direct the employees as to get the best practicable service from them. Let me ask you, therefore, to consider for a moment some of the arguments for the Plumb plan, and some of the arguments for a continuance of private ownership and management.

Under the Plumb plan, the public would buy the railways and guarantee their operating expenses and the interest on the money invested in them. Thus the public would assume all the risks of losses being incurred. The managing board of the railways would be composed one-third of representatives of the public, one-third of representatives of the officers, and one-third of representatives of the employees. This means that it would be composed two-thirds of employees, since under this system there would be practically no difference between officers and employees. A board composed entirely of officers and employees would fix all salaries and wages. If any surplus over interest on the investment in the railways were earned, the employees would get one-half of it. It is claimed that the adoption of this plan would establish industrial democracy on the railways, and would be beneficial to those employed by them and to the public.

Defects of the Plumb Plan

To my mind, the plan has one fatal defect. No business is ever well managed unless it is managed either by its owners or by persons selected and removable by them. The reason is, that in order that a business may be well managed it must be managed by or on behalf of persons who will not only gain if it is well managed, but lose if it is badly managed. Under this plan, all the risks of loss would be taken by the public and not by the employees, who would be in control of the management, while if any profits were made the public would get only one-half of them and the employees the other half.

But, the advocates of the Plumb plan answer, the employees are now opposed to private ownership and management because if any profits are made they go to the rich capitalists, who are alleged to own the railways, and the employees cannot any longer be expected to work efficiently to produce profits for the capitalists. As a matter of fact, this allegation that the owners of the railways get the bulk of the benefits of their operation under private ownership is not true. In 1917, the last full year of private operation, the employees received in wages about $1,750,000,000, while the net operating income of the railways, out of which all interest and dividends had to be paid, was about $1,000,000,000. Since then the wages of the employees have been advanced to $3,600,000,000, or over 100 per cent. Of this advance in their wages $625,000,000 has been given by the Railroad Wage Board since the railways were returned to private operation, thus showing that under private ownership and management the employees can get large advances in wages if they are entitled to them. If the advances in freight and passenger rates recently granted yield as large earnings as they are expected to, the net operating income of the railway companies will be made only a very little more than it was in 1917. In other words, although the employees have been granted increases in wages exceeding 100 per cent, the owners of the railways have been granted practically no increases at all in the net operating income from which their interest and dividends must be paid.

How Employees Could Control the Railroads

Furthermore, it is not necessary to adopt the Plumb plan, nor any other plan of government ownership, to enable the railway employees to come into control of the management of the railways. They could acquire control of the management by acquiring the ownership of a majority of the stock of the railroads. Now, it may occur to you that this would be a difficult thing for them to do, but, let us see. The total outstanding stock of the railways amounts to $6,580,000,000. The recent advances in the wages of the employees was $625,000,000 a year. By a very simple calculation you will find that by merely saving their recent advance in their wages and investing it in railway stocks, and also investing in stocks the dividends they would receive from them, the railway employees could buy a majority of the stock of every railroad in the United States at par in five years. But at the present time the stocks of the railways are not selling at par, or for $100 a share, but for an average of less than $60 a share. On the basis of the prices at which railway stocks are selling now, if the railway employees would save merely their recent advance in wages and invest it in railway stocks they would, in three years, own a majority of the stock of all the railways in the United States, which would give them absolute control of the management.

But it may be said that the employees will never do this, that they will not make the sacrifices necessary to save the money, and that while they are capable of forming powerful labor unions they are not capable of so organizing themselves as to use their financial power. But to make such arguments is equivalent to contending that the employees are not capable of managing the railways, because men who have not enough self-control to save a comparatively small part of their incomes, or enough brains to invest it wisely, have not the ability to manage the railways of the United States. If they have not the ability to manage the railways of the United States, then of course the adoption of the Plumb plan would be disastrous to the public and, in the long run, to the employees themselves.

Duties of the Railroad Officers

On the whole, it seems to me that the arguments against adopting the Plumb plan and continuing the present system of private ownership and management are overwhelmingly conclusive, since under the present system of private ownership and management the employees already have the power to acquire control of the ownership, and through it the management of the railways, if they have the character and brains to do it. But if the system of private ownership should be continued, then it seems to me the duty of every railway officer, high and low, and the duty of every employee is obvious. Their duty is, first, to put forth their best efforts to promote the most efficient possible operation of the railways, and, secondly, having done this also to exert themselves to get for themselves the working conditions and the compensation to which they are justly entitled. As to the supervising officers specifically, it seems to me their plain duty is, acting for the management, to treat the employees fairly but at the same time to spare no effort to cause every employee to give a fair day's work for a fair day's wage. What is a fair day's work? I have never opposed or criticised the establishment of the eight-hour day in industry, although I believe there are conditions under which it is desirable that a man should work more than eight hours. I began my working life as a printer and spent ten hours each day in work and my evenings in study, and I have had to work and study considerably more than an average of ten hours a day all my life because I had to educate myself. As for eight hours' work, it is as little as any man ought to do in a day, and if a man works only

eight hours he ought throughout the day to do the best and the most work of which he is capable. If all of us are to be supplied with the necessities, the comforts and the luxuries which are essential for human existence and happiness, the world's production must be increased and it cannot be increased sufficiently, at least under present conditions, to provide the necessities, comforts and luxuries for all of us unless we all work hard and well.

The Present Problems of the Railroads

At the present time, as you know, the railways are unable to transport all the commodities that this country can produce, and their inability to do so is limiting the amount of commodities that are being produced. Failure to increase the facilities and capacity of the railways would mean that there could not be any further increase of the production of coal for our industries or homes, grain from which to make our bread, and of lumber and other materials from which to construct additional business buildings and houses in which to live. Therefore, no matter how you view it, failure to maintain and increase the efficiency with which the railways are operated is bound to result in a national calamity from which we shall all be sufferers.

The immediate problem confronting the railways is that of handling all the traffic that is physically possible with the facilities they have at the least practicable expense, consistent with the present wages of labor and the present prices of material. Another problem none the less pressing which is confronting them is that of increasing the facilities so they may be able to handle more business than possibly can be handled with existing facilities.

I have no criticism whatever to make upon men having common interests who organize as you have to promote those interests, but such organizations should be made not obstacles but aids to furthering not only the interests of their members, but also the interests of the industries in which those composing them are employed, and also the interests of the public. It seems to me very plain, and I am sure it is plain to you, that it is to the interest of the railways, to the interest of the public and your own interest that you shall use all your influence and all your ability to increase in every way you can the efficiency of the operation of the railroads of the United States.

SEVENTY-THREE-YEAR-OLD LOCOMOTIVE IN SERVICE IN ENGLAND

BY E. C. POULTNEY,
M. Am. Soc. M. E., A. M. Inst. M. E.

Much interest has been caused recently by the reappearance of the famous London & North Western locomotive "Cornwall" in main line service. The photograph accompanying this article shows the engine "Cornwall," now 73 years old, assisting the "Patriot,"* one of the latest London & North Western 4-cylinder superheaters express locomotives of the "Claughton" class on the 1:15 P. M. Scotch Express from London. A description of the "Claughton" class express locomotives will be found in the *Railway Mechanical Engineer* for November, 1915. The following particulars and brief historical sketch of the locomotive "Cornwall" may be of interest:

The "Cornwall" was built during that period of English railway history known as "the Battle of the Gages," occasioned by the policy of the then Great Western directors, acting on the advice of their engineer Brunel, in adopting the 7-ft. gage as against the 4 ft. 8½-in. gage inaugurated by Stephenson and used on all other lines. Excellent records for speed having been claimed for the Great Western 8-ft. single driver express engines, Francis H. Trevithick, then the locomotive engineer of the London & North Western at Crewe, and a strong advocate of the narrow or 4 ft. 8½ in. gage, built, in 1847, the engine "Cornwall" having single driving wheels 8 ft. 6 in. in diameter, with the idea of showing that whatever could be done in the way of speed on the broad gage could be equally well done on the narrow. The engine was completed in November, 1847, and when first built the boiler was placed below the driving axle in order to obtain a low centre of gravity. Two steam domes were fitted to the original boiler, each joined together by an internal steam pipe taking steam to the "outside" cylinders, which were 17½ in. by 24 in. A safety valve was fitted to each dome.

It does not seem to be quite clear as to how many wheels the engine had when first built; some say eight were used—four in a group at the leading end, but not in the form of a "Truck" or "bogie," then the drivers and a single pair at the trailing end. Drawings of the engine thus equipped have several times appeared, but it is thought that such an arrangement was only proposed prompted by the fact that several Great Western engines of the period were so designed, and that in reality the engine always ran on six wheels as shown in the photograph. In 1858 the engine was rebuilt with a new boiler placed above the axle. Before being rebuilt the engine was shown at the London Exhibition of 1851. It is also reported to have attained a speed of 117 m.p.h. down a grade between Madeley and Stafford on the North Western main line. After being rebuilt a second time by the late F. W. Webb, the engine was stationed at Edgehill, near Liverpool, in 1890, and was principally used in running the 45-minute express trains between Liverpool and Manchester. The "Cornwall" was taken off the Liverpool and Manchester trains in 1902, and finally was taken out of service in August, 1905, being considered amongst those whose work is done. The engine was actually in work 58 years, and from the time it was rebuilt in November, 1858, to August, 1905, it ran 928,838 miles. No record of her mileage prior to 1858 is available.

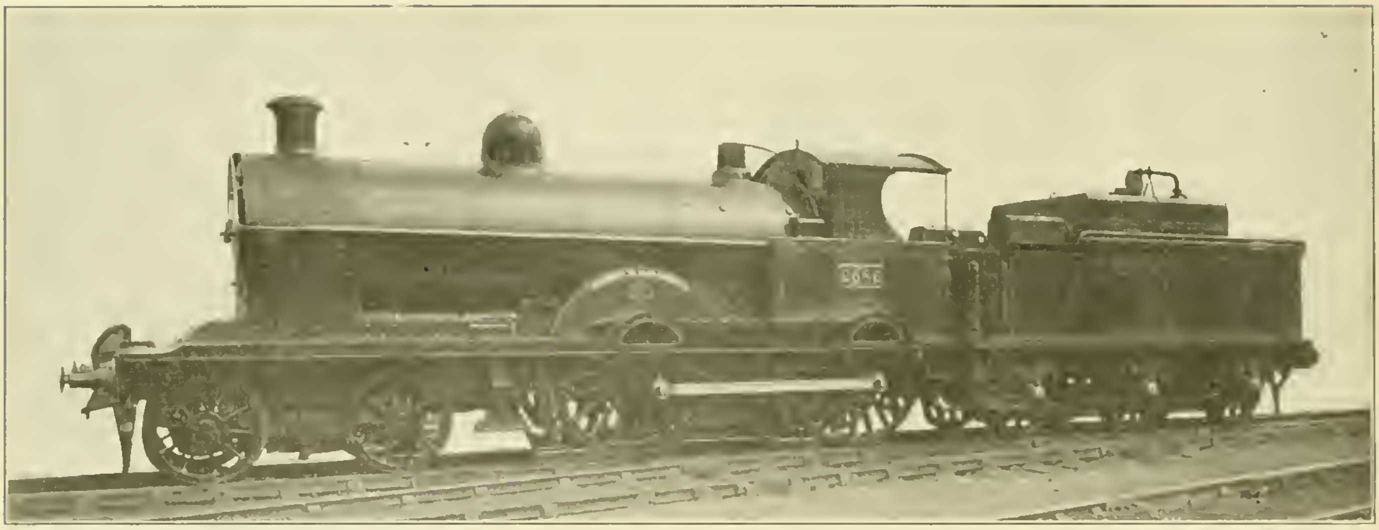
English Locomotive "Cornwall"

After being taken out of service the engine was used for the Chief Mechanical Engineer's private coach; the coach, which runs on six wheels, being arranged with a coal bunker at one end, was coupled direct to the engine, a tender being dispensed with.

The following are the leading dimensions of this interesting locomotive:

Heating surfaces:	
Tubes	981.0 sq. ft.
Firebox	87.3 sq. ft.
Total	1,068.3 sq. ft.
Grate area	15.0 sq. ft.
Weights in working order:	
Leading wheels	21,952 lb.
Driving wheels	28,000 lb.
Trailing wheels	13,440 lb.
Total	63,392 lb.
Diameter of driving wheels	8 ft. 6 in.
Size of cylinders	17½ in. by 24 in.
Steam pressure	140 lb.

*This locomotive was named "Patriot" in memory of the L. & N. W. employees who were killed in the war.

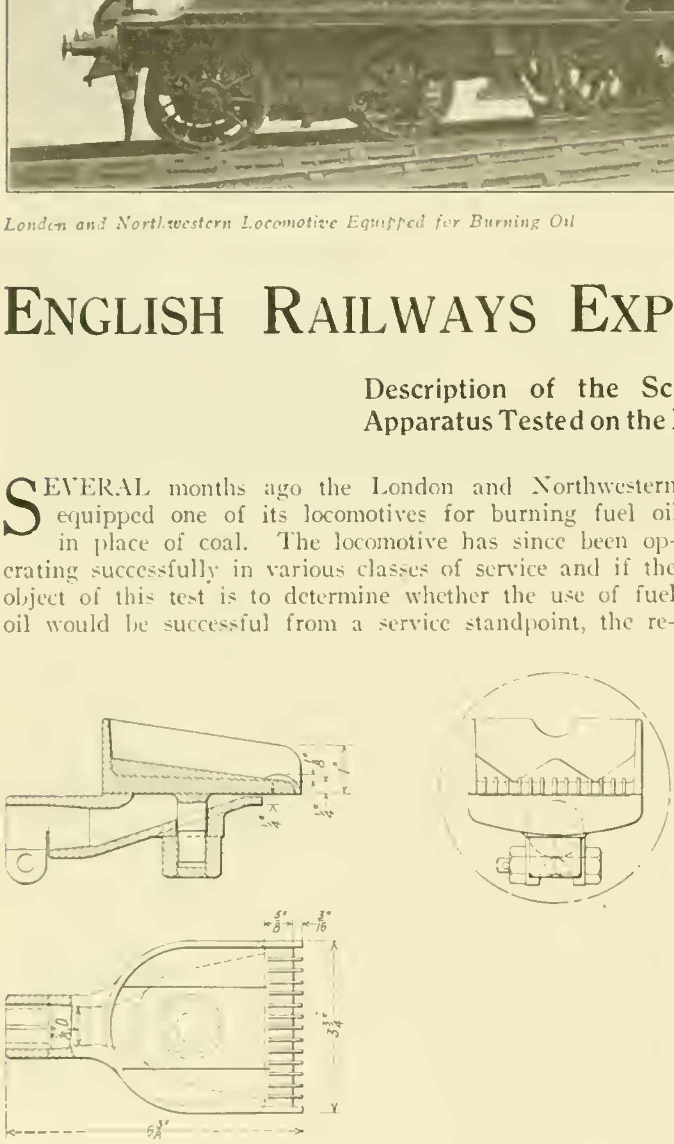


London and Northwestern Locomotive Equipped for Burning Oil

English Railways Experiment With Fuel Oil

Description of the Scarab Fuel Oil Burning Apparatus Tested on the London and Northwestern

SEVERAL months ago the London and Northwestern equipped one of its locomotives for burning fuel oil in place of coal. The locomotive has since been operating successfully in various classes of service and if the object of this test is to determine whether the use of fuel oil would be successful from a service standpoint, the results have so far been eminently successful. The extension of fuel oil use to additional locomotives will, it is presumed, depend very largely upon the availability of this fuel in comparison with coal. The experiments were undertaken on the initiative of the London and Northwestern but the results, particularly from an economic standpoint, will be of importance to all English railways.

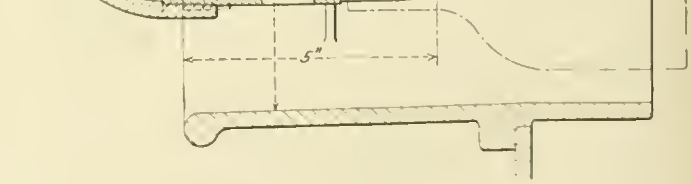


Details of Scarab Burner

Application of Oil Burning Equipment

The work of conversion to oil burning was carried out at the Bow Works of the London and North Western Railway Co. Certain of the parts were manufactured at the Crewe Works, while others were supplied by the Scarab Oil Burning Company of London. Immediately upon the completion of the work at Bow, the locomotive was steamed out under oil, and, after carrying out a series of preliminary runs and assisting main line trains, it was put into passenger service, first on a slow train to Bletchley, then on a medium fast train to Rugby, and finally on the London and Birmingham service.

The firebox of the locomotive is of the narrow deep type and presented considerable difficulties in the way of fitting a satisfactory oil burning system. The minimum permissible clearance between the bottom of the ashpan and the rails is such that no little ingenuity was necessary in order to fit a suitable oil burning ashpan with its necessary air ducts. To secure the maximum efficiency with liquid fuel, in a furnace, and obtain complete combustion without excess of air or the production of smoke it is necessary to provide a burner capable of thoroughly atomizing the oil without liability to stoppage on any account, and of performing this atomization with equal efficiency over a wide range of consumption. The interior of the furnace should be so fitted with firebrick that the atomized oil is completely consumed, and the flame so directed that the heat generated is applied most efficiently to the heating surface of the boiler. It is necessary, further, that the air supply and its



Top View of Scarab Burner

control be so arranged that only the requisite amount of air necessary to complete the combustion is admitted at such points that complete combustion is at once formed.

Description of Apparatus

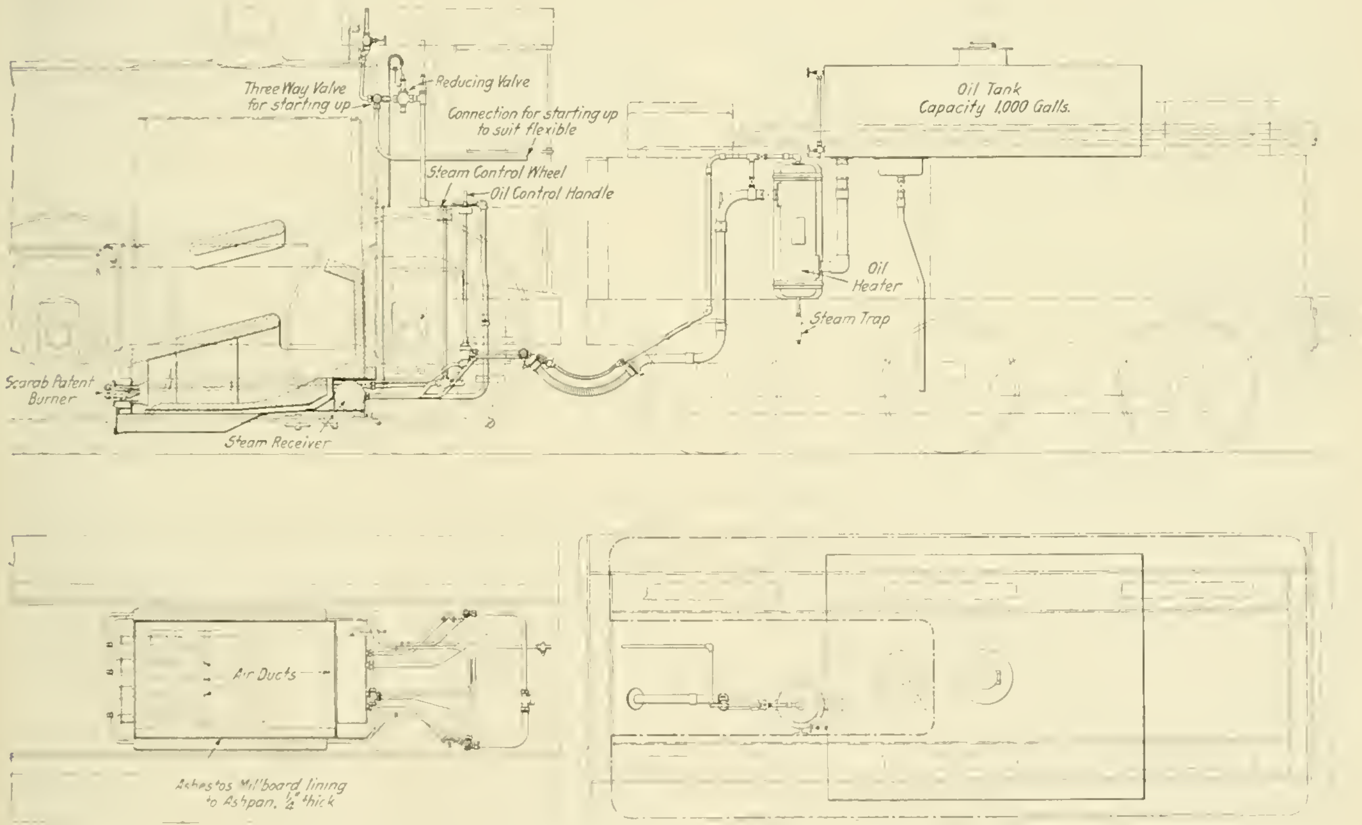
The Scarab burner does not differ in principle or mode of operation from the type of oil burner ordinarily used in locomotive service in this country. The fuel oil is led by means of a pipe under control of a needle valve to the upper side of what may be termed an open-ended tray. The oil falls on to this tray and immediately spreads over the whole surface, eventually finding its way over the open end in the form a fine stream or ribbon. A number of small fins are arranged along the open edge, in order to ensure that the ribbon of oil passing over the edge is of even thickness from side to side. Immediately under the tray previously referred to, is a space to which the steam or air forming the atomizing agent is led by pipes under the control of a valve. The atomizing agent is supplied at a pressure up to 15 lb. per sq. inch for the maximum rate of burning, and is controlled down to about 5 lb. per sq. inch for the lowest rate of burning.

By reference to the general arrangement drawing herewith, it will be seen that the burners are placed in the smokebox end of a special ashpan below the foundation ring of the firebox. The flame is projected towards the rear end of the firebox, and thence deflected towards the tubeplate; in conformity with the almost universal practice in this country, three burners are installed, and they are so connected to the oil and steam supply that the center burner, the two outside burners, or all three burners can be used. However, after some preliminary runs were made, it was found that the best results were obtained with the center burner operating only, and this burner was accordingly provided with a nozzle capable of dealing with 160 gallons of oil per hour. The outside burners are now provided with nozzles of about 20 gallons per hour capacity, and are used as "pilot" burners for maintaining steam while the engine is standing.

Elaborate Brick Arch Arrangement

A low arch is provided immediately over the burners, in order that the heat of the first ignition of the oil spray may be concentrated, and complete combustion effected as soon as possible. A small arch before the coal fire door serves to deflect the rush of flame from this door and the arch across the center of the firebox directs the flame all over the fire box surfaces and obviates a short circuit to the boiler tubes. A certain quantity of air is admitted through the burner casings themselves. This air is not under control, and simply provides the oxygen necessary for the initial combustion of the oil spray. Additional air enters through a damper placed below the firebox, and it is heated by its contact with the hot surfaces of the ashpan exposed to the flame. A considerable proportion of air travels to the burner by a passage provided immediately underneath the nozzle: a further portion enters the furnace through a number of small holes in the firebrick false bottom of the ashpan, a few feet in front of the burner nozzle. The remainder of this air supply is allowed to pass into the furnace close to the back plate of the firebox, and, having been highly heated on its way, it is admitted to the furnace so as to provide the necessary oxygen to complete the combustion of the already ignited oil spray.

The steam for atomization is taken from the top of the boiler to a reducing valve set to deliver steam at 15 lb. pressure, which is conveyed to a receiver placed longitudinally in a space provided at the back of the ashpan. A safety valve is provided on the low pressure side of the pipe line. From the receiver, steam is conveyed by pipe lines to the burners through regulating valves operated from the cab. A connection for starting up the engine from cold by means of an auxiliary supply of air or steam is fitted in the



Arrangement of Oil Burning Apparatus Applied to English Locomotive

cab. This connection is also fitted with a pipe leading from the blower ring in the smoke-box for creating a draught when starting up. Low pressure steam is taken from the receiver back to the oil heater on the tender, also to the oil pipe line leading to the engine, suitable valves being fitted so that all oil in the pipe line may be blown out into the ashpan at the end of the day's run. This ensures that the oil pipes will be clear for starting up when required. From the main oil tank the oil flows by gravity through a specially designed heater. A thermometer is provided on the oil pipe line immediately after the heater to register the temperature of the oil. To prevent waste of steam through the heater, a steam trap is provided.

Results of Tests

Test runs which have been made with this locomotive indictate an average oil consumption of under 30 lb. per mile as compared with the coal consumption of 70 lb. per mile of this locomotive when it formerly used coal as fuel. The oil which has generally been used was of a very dark brown color and asphaltic in odor. The specific gravity at 60 deg. F. is 0.907, the flashing point is 180 deg. F., the viscosity at 70 deg. F. is 290 secs. The distillate is free from tar acids, and the calorific power is equivalent to 19,366 B.t.u.

The following table shows in detail the results that have been secured on this locomotive with oil fuel.

RESULTS WITH OIL FIRED LOCOMOTIVES ON LONDON AND NORTHWESTERN

Trip between	Distance Miles	Average speed	Weight of train Tons	Time standing	Oil used running Gals.	Oil used standing Gals.	Total oil used Gals.	Oil used per 100 ton mile Lb.
Euston and Birmingham	113	46.5	294	Birmingham—2 hr. 54 min.	402	68	530*	10.88
Birmingham and Euston	113	46	264	....	357	..	377*	9.25
Euston and Rugby	84¾	31.4	247	Rugby—55 min.	304	22	386*	14.18
Rugby and Euston	84¾	31.4	221	....	284	..	304*	12.3
Euston and Bletchley	46¾	25.5	203	Bletchley—1 hr.	220	38	318*	21
Bletchley and Euston	46¾	26.7	285	....	160	..	180*	11

* These figures represent the total oil used from lighting up to return to the terminal.

CAST IRON FOR LOCOMOTIVE CYLINDER PARTS

Frequent renewal of cylinder parts of locomotives results in greatly increased cost of maintenance to the railroads, and consequently the quality of the cast iron entering into their construction is a matter of paramount importance, particularly from the standpoint of wear. These parts include piston-valve bushings, piston-valve packing rings, piston-valve bull rings, cylinder bushings, piston packing rings, and piston-head or bull rings. It was found that ordinary high-silicon cast iron gave unsatisfactory wear, particularly in modern superheater locomotives, and the tendency has been toward a harder and stronger iron.

At the request of the U. S. Railroad Administration the Bureau of Standards has investigated the mechanical, chemical and microscopical properties of a number of packing rings furnished with service-mileage records, as well as arbitration-test bars, chill-test specimens, and miscellaneous samples from different manufacturers. All of this material was cast iron such as is used for the various cylinder parts. At the same time a review was made of the previous work and specifications on this subject, to ascertain as far as possible the practices of the different foundries and to suggest such revision of existing specifications as would be warranted by the results of the present and of earlier investigations.

The results of the tests are to be published in Technologic Paper No. 172 of the Bureau of Standards, by C. H. Strand, associate physicist.

Conclusions are drawn and recommendations made as follows:

1. On the basis of tests made by inspectors of the U. S. Railroad Administration and this bureau, which were substantially in agreement, it is concluded that air furnace or so-called "gun iron" is more uniform in character and on the average of somewhat better mechanical properties than cupola iron. The latter, however, often equals or even excels in mechanical properties the specimens of air-furnace iron tested in this investigation. The sulphur content of the air-furnace irons examined seldom exceed 0.06 per cent, while the cupola irons varied in sulphur content from 0.10 to 0.17 per cent.

2. The findings of the American Railway Master Mechanics' Association with respect to correlation of laboratory and service tests are confirmed in the present investigation. It was impossible, except in a very general way, to find any correlation between the quality of the iron as developed by laboratory tests and the mileage obtained in service. This is explained by the fact that many other factors besides the quality of the iron enter into consideration in the service results, namely, design, lubrication, method of handling the locomotive, topography of the country, character of water used in locomotive, etc. The ring from foundry B, which gave the exceptionally good service of 93,000 miles, showed no unusual properties in laboratory tests. It is for the reasons cited above that the conclusions and recommendations of this paper are based essentially upon laboratory tests.

3. The present specifications of the American Railway Master Mechanics' Association are somewhat lax in the requirements for mechanical properties. It is recommended that the transverse strength requirements of the 1¼-inch arbitration bar be increased from 3,200 to 3,500 lb. for castings one-half of an inch or less in thickness, and from 3,500 to 3,800 lb. for castings over one-half of an inch in thickness. It is further recommended that the minimum deflection requirements for both cases be increased from 0.09 to 0.11 inch. The division line of the casting thickness is changed from five-eighths of an inch of the American Railway Master Mechanics' Association, to one-half of an inch in order to conform to the recognized standards of the American Society for Testing Materials.

4. It is preferable to leave the chemical composition and the melting process used to the manufacturer, depending for the most part on the mechanical tests, and of these primarily upon the transverse test. The existing specifications allow a maximum of 0.70 per cent phosphorus and 0.12 per cent sulphur; there are no developments in this investigation which would warrant a revision of the maximum permissible amounts of these elements.

Acknowledgment is given to Capt. S. N. Petrenko and T. W. Greene for the mechanical tests and also to S. Epstein for the metallographic work. The co-operation of the chemistry division of the Bureau of Standards in making the chemical analyses is likewise acknowledged.

The paper also includes a proposed specification for cast iron cylinder parts.

EQUIPMENT ORDERS IN THE FIRST NINE MONTHS OF 1920.—The Class I railroads of the United States ordered in the first nine months of 1920, 1,403 locomotives, 40,254 freight cars and 814 passenger cars. Canadian roads ordered 154 locomotives, 10,773 freight cars and 174 passenger cars. The total orders for freight cars placed in the United States amounted to 57,172; in addition to the 40,254 placed by Class I roads, there were also 256 cars ordered by other roads and 16,662 by private car lines and industrials.

Uranium as a Structural Steel Alloy

Characteristics Apparently Suitable for a Wide Range of Application to Locomotive Parts

BY HUGH S. FOOTE

Metallurgist, Standard Chemical Company, Pittsburgh, Pa.

DURING the past decade the volume of alloy steel production has been quadrupled and the automotive and aircraft industries have made wonderful strides in development. The progress of these industries is very intimately connected with the betterment of alloy steels. With the development of alloy steels of greater strength, of improved capacity to sustain sudden loads, and with a greater resistance to vibration and wear, more weight may be eliminated, thus contributing to greater commercial economy in many ways. A steel possessing such capabilities should also have the following qualifications: A competitive cost price; simplicity in heat treating processes, and simple composition. The greater the number of alloys present in the steel, the more independent variables there are to influence its properties; while the fewer the alloys, the more simplified is the steel practice, the greater the purchasing efficiency, and the less inspection and routine chemical analysis.

The development of uranium steel has produced a type which promises to fulfill these requirements. In addition, uranium steels are not embrittled by high temperatures, nor do they show a tendency to crack under severe quenching; and because of the depth hardening effect of uranium, they are less liable to warp in heat treatment. This means economy through less regulation and fewer rejections of the steel.

The Influence of Uranium

To date, the industrial application of uranium has been confined to high speed tool steel. The evidence would seem to indicate that uranium promotes the formation of a complex carbide which is more readily soluble in gamma iron than the usual carbide of high speed tool steel. Since the cutting property of this type of steel is dependent upon the dissolved carbides, the function of uranium is in part to increase the cutting qualities. Inasmuch as uranium also belongs to the same group or family as tungsten, it may be assumed logically that uraninum also tends to increase the red-hardness.

The experimental work on the application of uranium to carbon and simple alloy steels has been carried on for four years. Uranium is one of the most powerful elements yet discovered for alloying with steel, and the most active in making steel respond to heat treatment. Microscopic examination shows that the uranium in structural steel probably combines with the cementite to form a double carbide of iron and uranium. It emphasizes the characteristics of the cementite to a greater degree than other carbide forming alloys and is effective with a lesser loss of ductility and in a wider range of temperature limits in its heat treatment than other alloys.

Dr. George K. Burgess, of the Bureau of Standards, states that unlike zirconium and titanium, uranium appears to enter into solution in steel, that is, it is a true alloying addition. In the normalized specimens a distinct martensitic and troostitic pattern is present, which is undoubtedly due to the presence of the uranium in solid solution, as otherwise the structure would be found to consist of granular pearlite and ferrite.

The introduction of uranium into steel in amounts over .60 per cent imparts no properties which are not obtainable with a lower percentage contents. This is illustrated by the following analyses:

Chemical composition, per cent. Carbon	Uranium	Elastic limit, lb.	Tensile strength, lb.	El. in 2 in., per cent	Red. area, per cent	Brinell
.46	3.02	85,700	125,200	18	41.6	241
.45	1.40	81,900	116,700	21.5	54.2	231
.44	.19	97,600	144,030	17.0	61.8	293

Heat treatment in each case: 1,500 deg. F., quenched in oil and drawn to 570 deg. F.

Uranium is not limited by carbon content for its effects. This is illustrated by an example in which the addition of .56 per cent uranium to a .19 per cent carbon steel gave an elastic limit of 110,000 lb., a tensile strength of 140,700 lb., with an elongation in two inches of 11.5 per cent, a reduction of area of 52 per cent and a Brinell hardness of 235, when quenched in water from 1,560 deg. F., and drawn back to 480 deg. F. Furthermore, uranium does not need the effect of an intensifier, such as is produced by chromium when used with nickel or vanadium to bring out its full influence. This point is illustrated by the comparison shown in the accompanying table.

COMPARISON OF CHROME-VANADIUM, CHROME-NICKEL AND CARBON-URANIUM STEELS OF MEDIUM CARBON CONTENTS

Chemical Composition

"A"—C, .54 per cent; U, .27 per cent; Mn, .61 per cent.
"B"—C, .50 per cent; Cr, 1.06 per cent; V, .20 per cent.
"C"—C, .50 per cent; Cr, 1.10 per cent; Ni, 1.75 per cent; Mn, .45 per cent.

Physical Properties

	Elastic limit, lb.	Tensile strength, lb.	El. in 2 in., per cent	Red. area, per cent	Brinell	Merit number
"A"....	226,000	248,800	10.0	35.4	477	2,488,000
"B"....	217,300	227,000	10.0	35.5	402	2,270,000
"C"....	200,000	215,000	8.0	35.0	400	1,720,000

Comparative static and dynamic tests were made between the usual bearing steel and uranium steel. The bearing steel contained 1.01 per cent carbon, 1.68 per cent chromium, .18 per cent vanadium and .34 manganese, while the uranium steel had a carbon content of .63 per cent, .40 per cent uranium and .50 per cent manganese. Comparisons of dynamic and static tests of these steels after being hardened and drawn back through a considerable range of temperatures are shown in one of the tables. Comparing the tension tests

STATIC AND DYNAMIC TESTS OF URANIUM AND CHROME-VANADIUM STEELS

Uranium Steel

Elastic limit, lb.	Tensile strength, lb.	El. in 2 in., per cent	Red. area, per cent	Brinell	Heat treatment	
282,700	322,400	6.0	14.5	600	Quenched	480 deg. F.
267,100	287,400	8.0	20.6	555	from	570 deg. F.
230,000	256,800	8.5	23.4	495	1,480 deg. F.	660 deg. F.
224,600	237,100	9.0	25.1	477	in oil,	780 deg. F.
180,900	202,700	11.5	33.8	418	drawn to	840 deg. F.
Charpy impact = 87 ft. lb. per sq. in.						750 deg. F.
Alternating impact = 538 and 456 blows						750 deg. F.

High Carbon Chrome-Vanadium Steel

Elastic limit, lb.	Tensile strength, lb.	El. in 2 in., per cent	Red. area, per cent	Brinell	Heat treatment	
Broke at 271,440		...	...	600	Quenched	480 deg. F.
265,850	285,220	2.5	4.2	555	from	660 deg. F.
217,900	234,140	4.0	10.7	477	1,500 deg. F.	750 deg. F.
203,090	217,320	7.0	20.9	444	in oil,	840 deg. F.
163,500	172,840	11.5	30.8	364	drawn to	1,020 deg. F.
Charpy impact = 53 ft. per sq. in.						750 deg. F.
Alternating impact = 498 and 412 blows						750 deg. F.

either on the basis of Brinell hardness or on that of static strength, it is seen that the superiority lies with uranium steel. The ductility of the uranium steel, particularly at the lower drawing temperatures, is remarkable. This property is utilized in obtaining the merit number by multiplying the tensile strength of the material by its elongation, thus giving a relative idea of the amount of work that must be expended upon the material to break it. In other words, its strength must be overcome through a distance represented by its ductility before it may be broken. The dynamic tests show that the uranium steel possesses a greater resistance to shock and vibratory stresses conducive to fatigue than does the high carbon chrome steel.

Heat Treatment

The heat treatment of steel is one of the most important operations to which it is subjected, and to obtain the highest physical properties by this means, it is necessary to have accurate knowledge of the critical or transformation points. Although the changes due to heat treatment are governed by definite laws, the same treatment cannot be applied to all steels with satisfactory results, for each type of steel responds best to its own characteristic temperature.

Up to a content of two per cent, uranium has no marked influence on the critical or transformation temperatures. The majority of determinations place the Ac_1 (decalescent) point in the interval of 1,365 deg. F. to 1,380 deg. F. and in steels with a uranium content under two per cent the beginning of the Ar_1 (recalescent) point is between 1,255 deg. F. and 1,275 deg. F. Leeds & Northrup, in carbon steels (carbon .20 per cent to .60 per cent) place the Ac^1 point at 1,367 deg. F. and the Ar_1 point between 1,275 deg. F. and 1,259 deg. F.

The quenching temperatures of uranium steels do not differ radically from those of carbon steels. In general, the heating for hardening should be slow, uniform, thorough and to the lowest temperature which will give the desired results. Contrary to the characteristics of most alloy steels of a carbide nature, those containing uranium are not inherently sensitive to prolonged heating or severe quenching.

In order to obtain the superior dynamic qualities and at the same time avoid the large grain size caused by the high temperature annealing it has been our practice to normalize uranium steels. The forged or rolled material is slowly and thoroughly heated from 1,650 deg. F. to 1,700 deg. F., cooled in the air until black, then annealed at a temperature which will give the desired softness or physical properties. The normalizing accomplishes the following purposes: First, the high temperature overcomes any sluggishness on the part of the uranium toward going into solid solution. Second, all strains caused by previous operations are eradicated while the crystalline structure is refined, and third, the steel is in the best possible condition for heat treatment.

The function of the quenching medium is to remove the heat from properly heated steel with sufficient rapidity to enable it to retain the martensitic constituent. In this connection it may be said of uranium steels that they do not give a tendency to crack when quenched in water as do steels alloyed with chromium.

FOURTEEN POINTS OF INDUSTRIAL RELATIONS

In a recent article in the Iron Trade Review, Robert E. Newcomb, of the Worthington Pump & Machinery Corporation, set forth the disadvantages of employee representation in the management of industry. Mr. Newcomb stated that the soviet form of control would probably not be a permanent success and offered as a solution of the industrial problem the following basis for relations between employer and employee:

1. The policy of directors and managers must be one of human interest in the welfare of the employee for the good it does the man.

2. Educate present foremen to the policy of the management by frequent individual conferences, as well as group conferences with the foremen. This is frequently neglected but of great importance, as the foreman is the key to the industrial situation and frequently unintentionally throws sand into the wheels of industrial harmony.

3. Use greater care in the selection of executives, especially the foremen, taking only those of high moral character and of broad human interest and train them to share responsibilities with employee and management.

4. Train an employee thoroughly with respect to his trade and in an unselfish way, thus fitting him for promotion and inspiring him with an intent to rise above his existing condition by his conscientious efforts and industry.

5. Scientifically organize and control the management of the establishment. Rule it with a firm, efficient, economic and just power, and human love.

6. Establish a wage system which will appeal to the individual and inspire him to his best efforts.

7. Encourage executives, and especially foremen, to have a friendly interest in the personal affairs of the employees.

8. Be prepared to advise an employee with reference to legal matters, medical attention, how and when to borrow money for building purposes, how and where to invest money in safe conservative investments.

9. Where the corporation is large enough, legal and medical advice and investments and loans should be handled by experts. In other cases the employment officer and the superintendent should know to what lawyers and doctors and banks to direct their employees to get the necessary advice.

10. Help the employee to acquire a home by making such arrangements with the bank as will enable him to procure funds. The company can usually take out a second mortgage which the bank will carry with the company's endorsement at no expense and small risk to the company. The home owner acquires a proprietary interest in his property and naturally acquires the instinct of a property owner.

11. For those single men and others who do not wish to acquire a home, provide means for investing surplus funds, such as conveniences for making deposits in the savings bank at the rate of so much per week, a method corresponding to the deductions for the Liberty loan.

12. Also provide some scheme whereby the employee can purchase stock in the corporation, weekly payments being taken from his wages.

13. Encourage sick and accident insurance, and if possible provide old age pensions. These should be provided by state legislation, but may be advantageously handled through private companies until such legislation is passed. These advantages should not be provided entirely free of cost to the employee, but may be provided in part by the corporation for the purpose of encouraging the employee to look out for the future.

14. Avoid anything and everything which has an indication of paternalism or charity. Executives should be democratic and take pains to recognize employees on the street and in all public places. Do not have or permit the executives to have too much official dignity; insist, however, that they maintain natural dignity.

Fuel Saving in France.—Following a vote of the Paris Municipality, the Prefect of the Seine Department has opened a competition, for which 100,000 francs have been set apart for distribution in prizes, with a view to arriving at practical means for attenuating the fuel crisis. The competition is to bear on the apparatus, products, or processes which can come into use either from the commencement of next winter or at a later date. When the competitors have been classified by the deciding jury, an exhibition is to be held of the schemes which are likely to give immediate results.—*L'Electricien.*

The Mechanical Stoker and Fuel Economy

Analysis of Some Conditions Obtaining in the Locomotive Firebox Provided with Stoker Operation

BY F. P. ROESCH
Standard Stoker Company

THERE is no question that the ever rising cost of coal, together with the presumably increased amount necessary to produce a gross ton mile, when comparing hand with stoker firing, has a material influence on stoker applications, not only on new, but to existing power on which the application might be warranted, in order to obtain the full potential power output from the locomotive in question.

Past experience, as well as repeated tests, have amply demonstrated that this opinion, apparently well founded, cannot be gainsaid. It is equally true, however, that the conditions surrounding the various experiences and tests have not been fully considered in all their phases.

It would appear that the mechanical stoker is not being applied through any intrinsic worth or capacity increasing possibilities essentially its own, but because either the new locomotives are becoming so large as to preclude the possibility of successful hand firing when worked to their capacity, or to the fact that the class of labor from which we formerly drew our enginemen is seeking occupation in fields where the work is less arduous.

In discussing stoker possibilities, the following are the arguments generally used against their application:

First—The engines do not steam as well when stoker fired.

Second—Stokers increase the delay at cinder pits, owing to their tendency to clinker fires.

Third—They increase the cost of maintenance per locomotive mile.

Fourth—They burn more coal per 1,000 ton-miles than the same locomotive hand fired.

I believe an impartial analysis of the foregoing objections will prove that none present well founded objections or impose conditions that cannot be overcome.

Stokers Not Responsible for Non-Steaming or Clinkering

The function of the modern stoker is to prepare the coal, (i. e., crush it to firing size), convey it to the firebox and distribute it over the grate surface. As all stokers handling mine run coal perform the first and second operations automatically, the steaming of the locomotive can only be effected by that part of the operation depending upon the fireman, namely, the amount of coal supplied to the firebox and its distribution. As the amount can be varied to suit the requirements, and as the modern stoker has a flexibility of distribution equal to that possible with the most expert scoop manipulation, it follows that if given the same attention as to quantity of fuel supplied and distribution over the grates, the introduction of fuel manually or mechanically should in no manner affect the steam generation.

How then can we consistently attribute the non-steaming of any locomotive to the stoker? Any analysis of such a charge will invariably point to the human agent, the physical condition of the locomotive or the characteristics of the fuel. And yet the writer knows of many instances, notably some where the stacks of a recent consignment of locomotives were from 1 to 3½ inches out of line with the exhaust nozzle, and where the failure of the locomotives to steam freely was attributed solely to the mechanical stoker.

Clinkers are formed by the fusion of iron pyrites, sulphur, etc., at low temperatures. It follows, therefore, that clinkers are primarily a characteristic of the fuel, aided in their formation, of course, by the manner in which it is handled. The charge has been made that clinker formation is aggravated by the introduction of steam jets over the fire. On the contrary, it has been proven that the moderate use of small steam jets are beneficial, as they are a material aid in the thorough mixing of the gases distilled from the fuel, a prime essential in perfect combustion.

Stoker Maintenance and Fuel Consumption

There is no question but that the application of any auxiliary appliance to any locomotive will increase the cost of maintenance. This applies with equal force to the air brake, the lubricator or any other adjunct, if the cost is simply based on the cost per locomotive mile; however, if the cost is based on the true barometer of locomotive operation, viz., *cost per ton mile per hour,* not only the stoker, but practically many other appliances can show a clean bill of health. The inconsistency of present methods of compiling statistics relating to locomotive performance was very forcibly brought out by Robert Quayle, of the C. & N. W., at the recent convention of the International Railway Fuel Association.

The fuel consumption of any locomotive depends altogether on the following factors: *First,* the characteristics of the fuel (i. e., the proportion of combustible to non-combustible or ash). *Second,* the condition of the boiler and its capacity to transfer heat. *Third,* the condition of the locomotive engine, insofar as economical steam utilization is concerned. *Fourth,* the service in which the locomotive is engaged, and last, but not least, the men in charge, or the manner in which the locomotive is handled and fired.

With all of the above factors equal, the only added increase in fuel consumption that can be attributed to the stoker is the additional weight to be hauled—each extra pound of weight requires a proportionate power output, regardless of whether the added weight is on or behind the locomotive—the steam necessary to crush, convey and distribute the fuel, the increase in spark losses and the losses due to improper combustion. The amount of fuel required to haul the stoker can be readily determined from the daily performance sheets, as, for instance, if this data shows a consumption of, say, 210 lbs. of coal per 1,000 ton-miles, then the weight of the stoker, multiplied by the coal consumption per mile, will give the coal chargeable to this item.

The fuel required to operate the stoker must, of course, be determined from the steam consumption. This by test for the engine and calculation for the distributor consumption, has been found to vary from 0.5 per cent to 2 per cent of the steam generated by the boiler, the difference depending on the type of stoker used (See report of Pennsylvania Railway tests in the *Railway Mechanical Engineer* of April, 1920, page 199.) This factor holds good under practically all conditions, as where a greater demand is made on the boiler, a correspondingly increased demand is made on the stoker, and vice versa.

Spark Losses Due to Mechanical Stokers

That under some conditions there should be an increased spark loss with stoker fired locomotives is clearly evident when we consider the fact that spark losses are almost directly proportionate to the amount of slack contained in the coal and the height at which it is introduced into the furnace. As with the modern stoker, the coal is all passed through a crusher

before it enters the firebox, it follows that the slack must necessarily be increased over that obtaining with hand firing when the large lumps are simply cracked with the coal pick, if they are broken at all. While the slack content is a vital factor, yet the height at which the fuel is introduced is even more so, tests having shown that with the older type of stoker having a distributor located above the fire-door, the spark losses were reduced 30 per cent by cutting out or blanking this opening.

The spark loss, however, can be materially reduced, and with some types of stoker, practically eliminated, by simply increasing the length of the brick arch. Such an increase will not only reduce the spark loss, but improve the combustion, increase the firebox temperature, reduce the tendency toward stopped up tubes, increase the superheat, etc. True, there have been objections urged against the long arch, but principally by the firemen, on the ground that a long arch made the engines too hot at the door. However, with the application of the stoker, this objection loses its weight, as the fireman is no longer exposed to the furnace heat, and it might be well to note that as a long arch increases the heat at the door, it must follow that it increases the heat at the door sheet, thereby increasing the furnace efficiency.

Combustion in the locomotive firebox depends first upon the presence of the correct amount of air, and second on the thorough mixture of the air with the distilled gases. In the locomotive firebox the air is usually admitted through the grates and the fuel bed. Given a coal running high in non-combustibles, or an imperfect distribution of fuel, the admission of air becomes a very uncertain and in a measure uncontrollable quantity.

As a matter of fact, we know but little of what actually takes place in the locomotive firebox under the varying conditions of service. Our draft gages can only be inserted to a limited distance, hence can only register a local condition (i. e., the vacuum obtaining in the immediate vicinity of the opening). On the data so obtained we base our theories as to what is going on in other parts of the firebox. Aviators have found what they term "air pockets" or strata of air of lesser density than the surrounding atmosphere. Is it not reasonable, therefore, to assume that if such differences in pressure can occur in a practically undisturbed medium as compared with firebox conditions, that we have disturbances, air pockets and high and low pressures in the firebox likewise? And further, granting this hypothesis, does it not follow that these conditions vitally affect the efficiency of combustion?

Air Supply a Vital Factor

Tests conducted by the Bureau of Standards clearly demonstrate that where the air was introduced through the fuel bed alone, there was practically no free oxygen at a point three inches above the incandescent coals, indicating beyond the question of a doubt that the amount of air so admitted was insufficient. Again, many can bear witness to the fact that it is frequently necessary to hold the firedoor partly open, and with some coals, entirely so, to make up for the deficiency. With a locomotive hand fired, the needed amount is passed in through the opened door, not very efficiently, perhaps, but introduced nevertheless. In stoker firing the door is only opened when the fireman wants to observe the condition of the fire; consequently, practically all air must be introduced elsewhere. Where no other provision is made, the only point of entrance is through the grates and fuel bed; therefore, if the distribution is not uniform or the fuel bed is too thick, imperfect combustion and the attendant fuel loss is bound to ensue.

The necessity for an increased supply of air was fully recognized by F. F. Gaines and others years ago, when efforts were made to introduce the hollow arch on hand fired locomotives. If that was the case at that time and with that type of power, surely the necessity is doubly emphasized with modern power stoker fired. Therefore, is this not a vital point to be considered both by stoker manufacturers and railway mechanical men? Prof. Endsley echoed the thought at the 1920 convention of A. R. A., Section III, Mechanical, when he recommended the introduction of additional air in finely divided streamlets. His argument is too sound to warrant any effort at contradiction.

In the discussion of a report on mechanical locomotive stokers, the consensus of opinions expressed, as well as the results obtained at the Altoona testing plant, indicated that under moderate rates of combustion, hand firing was more economical than stoker firing, but at higher rates the stoker gradually approached expert hand firing in efficiency. The answer can be found in the preceding paragraphs, but to save reperusal, we can say, at moderate rates the fireman has ample time to so scatter the coal as to maintain a practically level fuel bed, and, as the time between fires is more infrequent, a lesser amount of air is introduced through the firedoor; while at the higher rates the continued opening of the door admits too much cold air, thereby retarding combustion, and the haste at which it is necessary to introduce the coal precludes effective scattering. If, however, with the stoker the same uniform spreading of the coal had been possible as with hand firing, and some provision had been made to introduce the additional air required above the fire, there is no question but that at the lowest rate the fuel consumption would be practically the same in both instances with no showing in favor of hand firing.

The entire subject is worth the careful study of all who are concerned in reducing the cost of locomotive operation, as with the ever increasing cost of fuel, no item that will in any way reduce the amount required per 1,000 ton-miles per hour is negligible. The stoker is here to stay, and its use will gradually be extended. Locomotives will continue to be operated from light to maximum capacity. The same amount of coal can be made to produce the same unit of work under proper conditions, regardless of whether it is placed in the firebox manually or mechanically.

Freight Car Production—Eight Months' Figures.—Figures of production reported by 23 leading car building companies associated with the Railway Car Manufacturers' Association show that the car building industry in August was working at a slightly higher percentage of capacity than in July. The number of new freight cars delivered in August totaled 3,056 for domestic service and 1,184 for export, as compared with 2,583 and 380, respectively, in July. The deliveries of passenger cars totaled 21 for domestic service and 13 for export. Car repairs totaled 2,818, as against 2,491 in July. At the end of August there were 49,442 freight cars for domestic service on order and undelivered, 861 passenger cars and 27,031 heavy repairs.

Cost of Railroad Fuel.—The increase in the cost of coal purchased by railways, in July, 1920, as compared with the cost in July, 1919, is shown in a compilation made by the Interstate Commerce Commission from reports received from 159 railroads. In July, 1920, these railroads purchased 9,627,491 net tons of bituminous contract coal at an average price at the mines of $3.24 per net ton, as compared with 8,880,021 net tons in July, 1919, at an average cost of $2.47. They also purchased 1,518,444 tons of spot coal at an average price of $6.01, as compared with 476,758 tons last July at an average of $2.40, an average of $3.58 for contract coal, as compared with $2.42 last year, and $8.36 for spot coal as compared with $2.51, while industries paid $4.40 for contract coal and $8.44 for spot coal, as compared with $2.13 and $2.04 last year. For anthracite coal the railroads paid an average of $4.23 for contract coal and $4.50 for spot coal, as compared with $3.45 and $3.04 last year. In the New England district the average was $7.14 for contract coal and $10.54 for spot coal as compared with $5.46 and $5.33 last year. The utilities paid $4.61 and $6.28 as compared with $3.19 and $5.15 last year, and the industries $2.48 and $4.85 as compared with $2.76 and $3.25.

BEST METHOD OF HANDLING FREIGHT TRAINS*

In order to handle freight trains efficiently and economically, it will be necessary to take into consideration the locomotive which hauls the train, as well as all other equipment used in doing the work; the locomotive must be put in the best possible condition before leaving the shop, so that it can handle the train efficiently and economically. With the eight-hour day and time and half time for overtime, the locomotive must haul the allotted tonnage over the division in as short a time as possible. This cannot be done with a 50 per cent engine.

CONDITION OF CARS

Cars should be in good condition before being sent out in a train to avoid delays due to accidents on the road. In order to do this, cars should be properly inspected and repairs made, or the cars switched out. It is necessary to have receiving yards laid out so that the work can be done quickly, and facilities should be provided to take care of all the details of inspection at one time.

All trains when stopped in receiving yards should have couplers stretched from engine to caboose; this can be done by having some hand brakes set on the rear of the train and have the engine pull the slack out. It is better to delay a train in the yard for inspection and repairs than it is to have it delayed out on the road. While in the yard only one track is blocked and other trains can pass on some other track, but on the road, when stopped by an accident, other following and opposing trains, in charge of crews making overtime, are blocked. When a train is delayed in the yard there is no crew time to be considered.

The same can be said of hot boxes. With the long and heavy trains that are being handled today, when you have to set out a hot box about 75 or 90 cars from the engine, it takes time and very often results in damage to other cars in the train.

All trains when stopped in the yards before the engine is cut loose should have the air brakes applied with a full service application, so that the air inspectors can go over the train and mark up the piston travel and defective brakes or brakes that are cut out, so that cars can be given the proper attention before being sent out of the dispatching yard. If the defect is such that the car must be shopped, it can be switched out while switching the train and then it will not have to be done after the train is made up, which very often delays the crew at the start of the trip and causes overtime.

All despatching yards should be provided with a yard air brake testing plant, and as soon as the train is switched the air should be coupled up from the yard plant and brake pipe leakage taken up, piston travel adjusted and retaining valves tested.

When the train and engine crews arrive, all that they will have to do is to couple the engine to the train and charge the brake pipe to the maximum pressure carried and test to comply with the rules in effect on the road. It has been found when trains have been worked properly by air men, all that is necessary for the crew to do is to know that the brakes will apply and release at the front and rear end of the train before leaving the yard.

HANDLING FREIGHT TRAINS ON LEVEL DIVISIONS

The trains on level divisions should consist of all through loads as much as possible, and the train should consist of as much tonnage as the locomotive can handle and make an average speed of at least 14 miles an hour. If it is necessary to fill out a train with cars for intermediate points or to give the train local cars, they should be switched on the front part of the train in station order, so that only the cars to be set off will have to be handled.

With the long heavy trains that are being handled at the present time, after a train has started out of the yard it should be kept moving, for the stopping and starting is what causes delays and damage to equipment.

The train should not be stopped for coal over the division and should be stopped for water as few times as is possible. In making stops for coal and water, the engineer should be very careful not to make spot stops with a heavy freight train.

All long and heavy freight trains should be stopped with one application of the air brakes and the engineer should endeavor to keep the slack bunched from the front end. This can best be done by making the initial reduction just sufficiently heavy to run the slack in and follow up with light reductions until the train is stopped. In order to keep the front end from running out, the engineer should make a reduction of about eight or ten pounds about 60 ft. before coming to a full stop. This is to keep the air brakes applying stronger on the front end to hold the slack in and leave the brake applied on the train when the engine is cut off. Engines so equipped give splendid performances both from capacity and fuel economy standpoints.

In starting a train with one engine, the engineer must be very careful until he has pulled all of the slack out of the draw-bars before fully opening the throttle. There is about 9 to 12 in. of slack between the cars, and this will increase on the front end in starting, due to the compression of the draw-bar springs and the dead weight of the cars that have not been started. The engine will move about 60 to 70 ft. on a 70 to 75-car train before the rear end moves on the level and more on an ascending grade.

In starting a two-engine train on level roads, the lead engine only should start to pull and take up all the slack that it can. Then the second engine should start to pull by opening the throttle gradually until the entire train is started, then increase the throttle opening as may be required. The train should be moved at a slow rate of speed for a distance of just one train length, so that the trainmen can look over the train and in case any brakes are sticking they can be released. Very often it is possible to locate a defective coupler in the train when it would not be noticed at any other time, except when the train is stretched out so far. This will occur at times when couplers are badly worn and the draft spring broken or worn.

DESPATCHING TRAINS FROM YARDS

Where the yard is equipped with an air-brake testing plant, see that the brake pipe leakage is below standard allowance and all other work done before the train is ordered to leave the yard, so that when the road engine arrives in the yard it can be coupled onto the train at once and make the road test.

The success of the trip greatly depends on the start out of the yard. The importance of having the train ready to move by the time it is called is readily seen, for one hour delay at the start means overtime on the eight-hour day and 12½ mile an hour basis.

The train despatcher must not stop trains unnecessarily, for an avoidable stop made by a heavy freight train means a loss of time in stopping, then getting the flagman in and starting, and very often the train is parted in trying to start, due to a broken coupler or coupler slipping by which might not have occurred if the train had not been stopped. There is also an excessive amount of fuel consumed by the extra stops and in trying to make up some of the time lost by the stops.

There is no economy in loading a freight train so that it

* From a paper presented at the convention of the Traveling Engineers' Association.

is unable to get over the division without making overtime.

HANDLING FREIGHT TRAINS ON MOUNTAIN DIVISIONS

On divisions where the grades are heavy and it is the practice of using one or more helpers on the ascending grades, it is important that no weak cars be used in heavy tonnage freight trains, if possible to avoid it. With the Mallet and Santa Fe type locomotives having tractive efforts of from 70,000 lb. to 105,000 lb. cars with weak end and center sills or weak couplers are very dangerous to handle in trains of this kind. There should be instructions given to all yard masters and car inspectors that cars that appear to be old or of weak construction should be switched out of heavy trains where helpers are used and placed in a train to be run without a helper or a train hauling light tonnage.

It has been demonstrated from time to time that it is not necessary to use hand brakes on freight trains on descending grades any more than it is on passenger trains, when the equipment is properly maintained. With the ordinary air brake, if properly maintained and manipulated, it is possible to handle freight trains on heavy descending grades with the air brakes with a greater degree of safety than with the use of hand brakes, because it is possible to do the braking more uniformly throughout the train and to maintain a more uniform rate of speed.

According to the information obtained from the different roads, the permissible brake pipe leakage on trains of 30 to 100 cars varies from five to eight pounds per minute, which is about all the air feed valve will take care of and about the limit of leakage with which an engineer can do a good job of braking. It has been found by actual tests on heavy mountain grades that it is very difficult to release the brakes on the rear end of 75 to 90 cars with a brake pipe leakage of over seven pounds, and if the brakes are not released on the rear end after each application the tendency for jerking the train and excessive wheel heating is greater.

Some roads are handling trains on level tracks as well as on heavy mountain grades with electric power, and some other roads are figuring very strongly on electrification. While this method of operation applies only to a few roads, we are of the opinion that more roads will take up the matter of electrification in the near future from the fact that with the electric locomotive the terminal delays can be reduced considerably, as well as delays in stopping for water and coal, and it has been demonstrated that an electric locomotive can be run over three divisions of over 100 miles each, by changing crews, without any delays to the locomotive. This would indicate a high point of efficiency from the fact that it could be a no-stop operation from one end of the division to the other. This would eliminate the pulling out of draw-bars and damage to equipment due to starting and stopping. It would also reduce the cost of brake shoes and other brake equipment.

On heavy grades the speed of the train is controlled while descending, by regeneration, but it must be understood that by regeneration the speed of the train is only held under control and it will be necessary to use the air brakes to stop.

The report was signed by Frederick Kerby (B. & O.), chairman; M. O. Davis (A., T. & S. F.), M. A. Daly (Nor. Pac.), P. G. Leonard (G. H. & S. A.) and Malon Laquay (Grand Trunk).

Discussion

The greater part of the discussion was devoted to the best methods of making water stops with long freight trains. The practice of stopping short of the water crane, then moving the train up slowly to the final stop, was commented on favorably by a number of the members. Where the more common practice of cutting off the engine is followed, it requires from 20 minutes to 1½ hours to release and recharge the brakes after the engine has been recoupled to the train, the time depending on the amount of brake pipe leakage. Furthermore, some of the members have found that an actual reduction in the amount of damage to draft gears has been effected by the practice of moving the whole train slowly to the final stop. The reason given for this was that stuck brakes often follow the recharging of the train. It was evident that the roads where this practice has been adopted are comparatively level and handle trains ranging from 3,000 tons to 4,000 tons. The opinion was that where unusually heavy trains are handled or where grade conditions prevail the only safe rule to follow is to stop and cut the engine off before moving to the water tank.

The incoming test and the yard charging plant were favorably commented on. The yard charging plant saves from 1 to 1½ hours' crew time in getting away from terminals.

The effect of slack action has been found of more importance on electrified districts than it was when steam motive power was used. Where regenerative braking is used no trouble is experienced in making emergency applications of the air brakes on descending grades. But when ascending great care must be used to prevent pulling out drawbars. The practice which has been developed is to first apply the brakes, then shut off the power gradually to prevent the heavy run in of slack due to the higher braking power immediately developed at the front end of the train.

Referring to the statement in the report that freight trains can be handled on mountain grades with power brakes only, it was stated that in order to do this retainers must be put in good condition before descending the grades, and the greatest success cannot be attained unless all railroads maintain the brake equipment as the laws require. Otherwise, the mountain roads will be required to do an excessive amount of work to put the equipment in safe condition.

THE EFFECT OF SLACK WEDGES

A discussion on this topic was presented in a paper on the general subject of locomotive upkeep, prepared by a committee of which J. C. Brennan (N. Y. C.) was chairman. In the discussion which followed the reading of the paper several of the members dwelt on the fact that, aside from loose binders or thimble bolts, the cause for practically all failures of frames over the driving boxes is slack wedges. Some difficulty has been experienced in getting wedges properly adjusted in the roundhouse. Unless the locomotive is properly spotted the machinist is very likely to find it standing so that the wedges appear to be tight and he frequently reaches that conclusion when the wedges have been reported by the engineman to be set up. The Franklin self-adjusting wedge was favorably commented on by representatives of the railroads on which it has been applied, some of the members reporting a decided decrease in the number of broken frames on classes of locomotives now equipped with this device. These wedges have been run for six months without touching the adjustment but all of those who have had experience with them emphasize the necessity of keeping them lubricated. In some cases it is the practice for the inspector to oil the wedge a little before each trip.

The difficulty of securing proper attention to the usual type of wedges on engines in pooled service was mentioned. In pooled service the Canadian Pacific has developed the practice of giving each engineman a copy of the work report turned in by the man who last had the locomotive, as a means of developing a more intelligent interest in the condition of locomotives on the part of the crew. It was also suggested that excellent results might be obtained if each engine man were given a copy of his work report, showing the conditions actually found in the roundhouse. This would tend to correct habitually wrong diagnoses on the part of the enginemen.

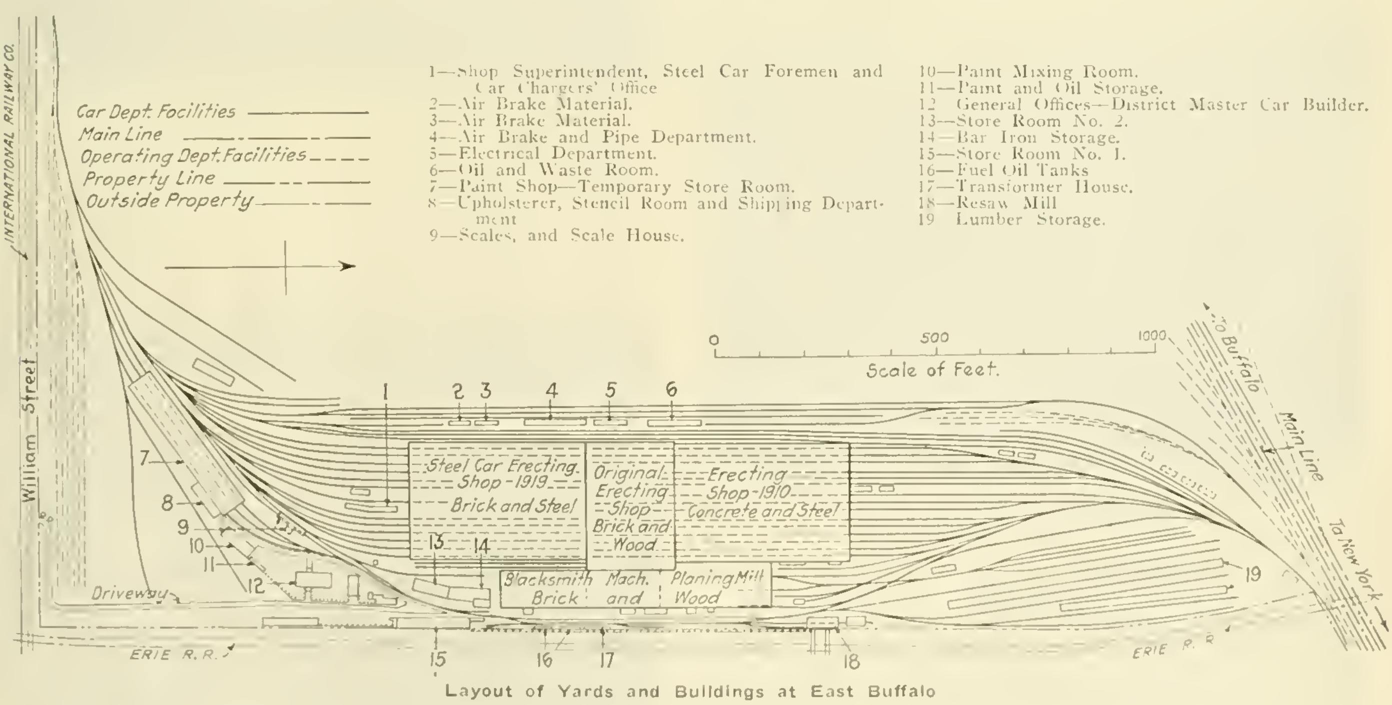
General View of the East Buffalo Car Shop

N. Y. C. Steel Car Shop at East Buffalo

Capacity of Building with Latest Additions 236 Cars; Overhead Cranes Eliminate Need for Material Tracks

THE New York Central maintains at East Buffalo, New York, the largest freight car shop on the system and probably one of the largest in this country devoted primarily to the repairing of freight cars. The original shop erected in 1865 has been greatly enlarged, extensive additions having been built in 1910 and in 1919. At present the buildings have a capacity of 218 freight and 18 passenger cars while the adjoining repair tracks provide space for 170 freight and 12 passenger cars. The force employed under normal conditions comprises about 900 men in productive labor and 75 in the supervisory positions.

The East Buffalo car shop is located south of the main line of the New York Central and extends for more than a half mile alongside the freight yard. The layout centers around the erecting shop, which is 275 ft. wide and 1,000 ft. long, this building alone covering an area of 6.3 acres. The drawing below shows the three portions of the shop—the original erecting shop at the center with the addition built in 1910, both of which are used for repairing wooden cars, and the new shop for steel car work built in 1919. The wooden car department covers an area of 275 ft. by 600 ft. while the steel shop is 275 ft. wide and 400 ft. long. Adjoining the erecting shop on the east side is a brick building 605 ft. long and 85 and 110 ft. wide in which are located the planing mill, machine shop, blacksmith shop and power house. The blacksmith shop is 85 ft. by 200 ft.; the machine shop 85 ft. by 160 ft.; and the planing mill 110 ft. by 200 ft.

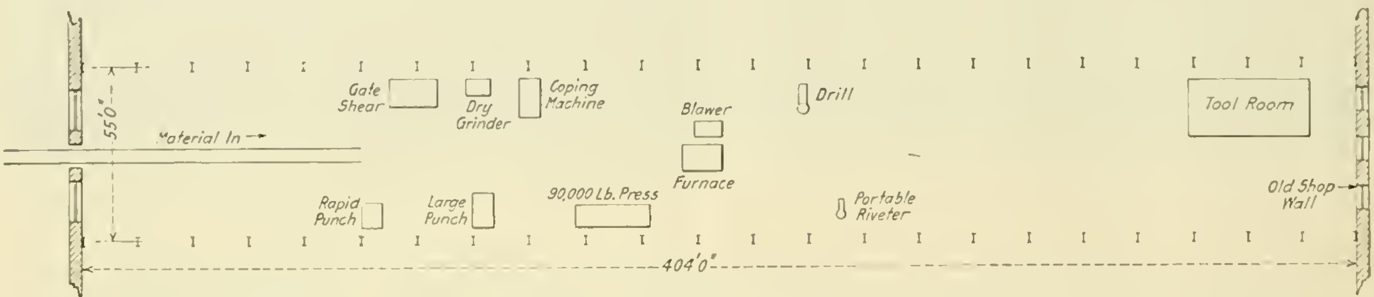


Layout of Yards and Buildings at East Buffalo

With this arrangement, an excellent routing of material is secured. The storehouses for castings, bar iron and finished material are at the south end of the shop, where they are most accessible to the blacksmith shop, while the lumber storage is easily reached from the north side of the planing mill. The machines are so arranged that the material is brought in at the ends of the shops and passes along without back movement for the successive operations and leaves the

last machine adjacent to the tracks leading to the erecting shop. At first thought it might seem that the location of the machine shop between the blacksmith shop and the planing mill would be a serious disadvantage but the amount of material handled in the machine shop is comparatively small with the exception of wheels and axles and tracks leading directly from the erecting shop are provided for handling these.

The power house occupies a space 45 ft. by 85 ft. between the planing mill and the machine shop. The electric power used in the shop is purchased from outside sources and this small area is ample for the boilers, pumps and compressors. A separate building opposite the machine shop houses the transformers and the switchboards for the main circuits. The combined rating of the machines used in the shops is 2,378 h.p. Steam power which is used for the steam hammers, for heating and for the fire pumps is supplied by one 100 h.p. and two 200 h.p. locomotive type boilers. Two air compressors each of 1,500 cu. ft. capacity and driven by synchronous motors furnish compressed air for the shops.



Arrangement of Tools in the Central Bay of the Steel Shop

The auxiliary buildings have been placed in convenient locations with respect to the main shop. A separate building is provided outside the planing mill for the resawing of second hand sills and other large timbers which can be worked over into smaller sizes. A paint shop 60 ft. wide by 360 ft. long with a paint mixing room adjacent is located at the south end of the shops. Owing to lack of space, this is used temporarily as a storehouse. The air brake department, electrical department and oil house are housed in separate buildings west of the main shop.


One of the Erecting Bays

As the new steel car erecting shop represents the latest practice in construction and equipment, a more detailed description will be of interest. The shop is of brick and steel construction with concrete footings extending to a height of about six feet around the walls. Both the side and end walls have a large window area, ribbed glass and pivoted steel sash being used throughout. The roof, which has six transverse square monitors, is built with wood purlins laid on the steel trusses and covered with wood planks and plastic roofing.

The building is divided into five longitudinal bays which accommodate 13 tracks. The two west bays each have three tracks, the center or machine bay has a stub track, and east of this is another bay with three tracks. Each of these bays has a 10-ton traveling crane of 51 ft. 4-in. span with a two-ton auxiliary hoist. The extreme east bay has three tracks but is not supplied with a crane. The lavatories and lockers are located on a balcony in the north end of this bay. The tracks are spaced 12 ft. 6 in. from the walls and 17 ft. 2 in. and 18 ft. between centers without any intermediate


South End of New Steel Shop

tracks for handling material or working on trucks. The truck work is done while the trucks are rolled clear of the end of the car and material is transferred by the overhead cranes. This arrangement eliminates waste space in the


Looking Down Central Machine Bay

shop and increases the car capacity. A transfer track extends across the north end of the steel shop and provides a convenient means for transporting material from the machine shop or blacksmith shop to any of the tracks in the five bays.

The arrangement of the equipment in the steel car shop

is shown in one of the illustrations. Comparatively little equipment has been installed, as prior to the erection of the shop the standard material for system equipment was made at other points and this practice is still followed to some extent. The machine facilities are ample to take care of the cutting and shaping of any parts that the shop is called on to replace. One piece of equipment that is worthy of special mention is a 90,000 lb. geared power press which has a capacity for bending 3/8 in. plates 10 ft. long.

While an extended description would be required to present a detailed account of the handling of work in the various departments, the list of machines shown herewith will serve to give an idea of the equipment needed for a shop of this size and the work that can be handled.

North End of the Erecting Shop, Planing Mill at the Left

LIST OF MACHINES, EAST BUFFALO CAR SHOP

Blacksmith Shop	
One power punch	One flanging clamp
One 2-in. bolt cutter	One 4-in. forging machine
Two 300-lb. Bradley hammers	One brake shoe key machine
One 1-in. bolt header	One single head bolt cutter
Two 2-in. bolt headers	Two 1½ in. triple head bolt cutters
One No. 4 bulldozer	Three 2-in. triple bead bolt cutters
One No. 9 bulldozer	One tire lathe
One pneumatic bulldozer	One heavy duty drill press
One bolt shear	Two 3,400-lb. steam hammers
Two No. 5 Hilles & Jones punch and sbears	Electric motors, total 157½ bp.
Tin Shop	
One wire machine	One burring machine
One double truss Cornish brake	Two turning machines
One 42-in. squaring machine	One 2-in. roller machine
One No. 24 punch	One 3-in. roller machine
One 18-in. bar folder	Two heading machines
One 42-in. bar folder	One Superior small turner
Wood Repair Shop	
Two 10-ton traveling cranes	One cross-cut saw
One rip saw	Electric motors, total 15 hp.
Waste Reclaiming Department	
Two waste reclaming machines	One emulsion machine
Pipe Department	
One No. 7 pipe machine	One angle cock grinder
One pipe cutter	Electric motors, total 10 hp.
Resawing Mill	
One cross cut-off saw	One exhaust fan
One band saw	Electric motors, total 65 hp.
Machine Shop	
One speed drill	One water pump, 10 in. by 8 in. by 12 in.
Two No. 3 milling machines	Three engine lathes
One 18-in. drill press	Two double end axle lathes
Two stand grinders	Two single end axle lathes
Three boring mills	One planer
One grindstone	One shaper
Two hydraulic wheel presses	One drill press
One blower	One radial drill
One journal truing latbe	One hydraulic press
One 1,000-cu. ft air compressor	One Universal grinder
One water pump, 12 in. by 8 in. by 12 in.	Electric motors, total 235 hp.
Wood Mill	
One column bracket cut-off saw	Two matchers
One cross cut-off saw	One gainer
Three swing cut-off saws	One timber framer
Four rip saws	One turning lathe
Two band saws	One trimmer
Two horizontal boring machines	One saw sharpener
One horizontal angle boring machine	Two band saw filers
One vertical hollow chisel mortiser	One band saw setter
One horizontal mortiser	One band resaw stretcher
Two vertical sill tenoners	One band resaw lap grinder
One door and sash tenon macbine	One planer knife grinder
Two moulding machines	One exhaust fan
One sbaper	One band saw
One 4-side planer	One combination machine
One dimension planer	Electric motors, total 447½ hp.

THE UPKEEP OF FREIGHT CAR EQUIPMENT*

BY J. W. SENGER
Superintendent of Rolling Stock, New York Central Lines West

Those who are directly connected with and responsible for upkeep, care and maintenance can best appreciate the difficulties experienced in passing through the period of the war. At the present time during the reconstruction period, due to the shortage of labor and material and the increased traffic that is moving and the scarcity of freight equipment, we are facing perhaps a bigger problem than the one with which we had to contend during the great conflict for the period mentioned. During the past three or four years a limited amount of freight equipment having been purchased, it is necessary to maintain equipment that in normal times would have been retired. Therefore, in order to bring this subject before you the writer has confined himself to the most important parts and divided the subject as follows: Facilities, Material, Organization and Repairs.

FACILITIES

Facilities are the most important factor in car repairs next to labor. Up-to-date shops equipped with modern machinery and labor saving devices being limited to taking care of the equipment, it must be realized that a 100 per cent output cannot be had at all times; particularly is this true during the winter season. For obvious reasons the facilities for repairs have not kept pace with the increased equipment. This matter should be one of careful consideration with a view of increasing the facilities as quickly as possible.

ORGANIZATION

Shop organization is also a vital point and in order to produce the maximum output should consist of capable men. The most important of these are the shop superintendent or general foreman and his assistants. It is generally found that when the work is divided better results are obtained than to have the entire shop or shop yard covered by one man, as this practice makes the head of each division responsible. Junior supervisors should be educated to fill the position immediately ahead of them, so that in the absence of the foreman the work will proceed without loss of efficiency.

Men in supervisory capacities should be selected from the ranks when possible to do so. This practice is an incentive to others. They should be men of a good personality, broad minded in their dealings with men and thoroughly conversant with the details of the work.

Valuable results are obtained by holding monthly meetings of the supervisors, bringing them into closer touch with each other and the practice in vogue at their respective points. Meetings places should be changed from time to time giving to all an opportunity to observe the conditions at the different points. Much valuable information can thus be obtained that will result in saving and greater efficiency and due credit given to those who are responsible for same.

MATERIAL

The shortage of material is a handicap in production, often necessitating the substitution of one kind for another. Careful attention should be given to the use of material, that none is wasted and all is used to the best advantage. Full co-operation should be had between the mechanical and stores departments in the handling of material that no unnecessary delay be had in supplying material at hand. Advantage should be taken of the scrap dock, as much good material can be obtained. The necessary machinery and supervision to reclaim material should be furnished.

REPAIRS

Under this heading the writer has divided the subjects

*Abstracted from a paper presented before the Central Railway Club, September 10, 1920.

into three classes; viz: general repairs, light repairs and running repairs:

General Repairs: This refers to both wooden and steel equipment receiving heavy repairs or that are rebuilt, at which time due consideration should be given to the strengthening of all weak parts, the application of betterments, such as steel underframes, steel ends, improved doors and fixtures, etc., the thorough overhauling and modernizing of trucks, eliminating unnecessary parts and bolts, and providing safety irons to prevent brake beams falling down. After the completion of general repairs a final inspection should be made to know that all parts are in a serviceable condition before the car is released for service.

Under this heading, I want to call attention to the importance of a final inspection at the shops after cars receive heavy or general repairs. This should be done by very competent men who should go over each and every part carefully, see that all the movable parts of the brake equipment are in their place, especially cotter pins, which should be properly spread, and other small items likely to cause failures en route and which the car repairers overlook—in other words, when a car leaves the repair track it should be O. K. for service in every particular.

I also want to call attention to a lot of old and worn-out equipment now in service and which, in my opinion, ought to be retired. If you will look over some of this equipment when it is on your repair tracks you will find that a large percentage of the cars have been given temporary repairs to carry another load or two. It seems to me we are only wasting a lot of good money by trying to keep such equipment in service; besides, it is taking up a lot of valuable repair track room which could be utilized to better advantage.

Light Repairs: Under this caption the writer refers to cars repaired on the ordinary repair track and comprises such repairs as replacement of draft timbers, end sills, sill splices, parts of floors, parts of roof, doors and door fixtures, journal boxes, column castings, truck bolsters, side bearings, brake beams and connections, etc.

Cars on light repair tracks should be gone over carefully for defects which may send them to the heavy repair track and avoid making light repairs when the condition is such as to warrant general overhauling. In connection with the light repairs enumerated, attention should be given to the brake equipment doing all the necessary work to put the brake in first-class operative condition.

This is also an opportune time to inspect the car for worn parts, spreading of cotter keys, adjustments of the piston travel, seeing that proper connections and brake levers are applied and that the hand brake and uncoupling levers are efficient, and periodical packing of boxes. If this is done is would prevent the cutting out of cars when returned to service.

Running Repairs: This is generally understood as repairs made in the classification or train yards, either by inspectors or follow-up men. Right here I wish to impress upon everybody's mind the importance of having the little things taken care of which are at times neglected; that is, renewing short or broken knuckle pins, worn-out brake hangers and keys, bolts, the application and proper spreading of cotter keys, removal of worn brake shoe keys, application of missing parts and correction of Safety Appliance defects. At this time the hand brake should also receive a thorough inspection, journal boxes should be examined to see that brasses and keys are in place, that no sign of previous heating exists and that packing is in its proper place and that there is enough lubrication to run the car to its destination. By giving proper attention to cars in the classification yards which, of course, includes proper inspection, nearly all of our road delay and expense of setting out cars en route could be avoided.

Quite frequently we hear complaints from other departments on account of too much time being consumed in inspection and repairs in the classification yards. Inspection and light repairs are very necessary to insure the train going safely to its destination without delay. While the work should be done as quickly as possible we should insist upon proper time for inspection and repairs being allowed to accomplish this.

In conclusion the equipment department of the railroads is passing through and experiencing one of the most strenuous periods of its history. The demand that has been made upon it by the operating department of the railroad, due to the necessity for car equipment suitable for transportation purposes, has tended to make it necessary to use all classes of equipment to the maximum. We have been called upon to supply cars not for the commodities for which they were originally built, but for other classes of service for which they could be fitted by temporary repairs. As a consequence we now find ourselves with equipment on hand which will require some time to build up to its former usefulness, and this cannot be very well accomplished unless all railroads provide themselves with newly constructed equipment which can be placed in service to relieve equipment now running, to enable the cars to be brought into the shop and receive general repairs or overhauling which will fit them for the service for which they were originally built.

Discussion

F. W. Brazier (N. Y. C.) in a written discussion considered what could be done to reduce the cost of upkeep. He advocated more care in designing and getting comments from the foremen to do away with troublesome defects. More thought should be given to the type of equipment to avoid features that are expensive to maintain. As an example, he cited the elimination of unnecessary nuts and bolts and also mentioned improved door fastenings and key connected couplers as important improvements. Undue emphasis is often placed on reducing the first cost of equipment; but if the design of cars built years ago had received more attention, conditions would be better now.

C. H. Hogan (N. Y. C.) expressed the opinion that the most important matter at the present time is the question of organization. Handling labor is difficult and requires men of good judgment. The foremen should get close to their employees and study their character if they wish to secure a fair day's work.

F. C. Pickard (D. L. & W.) pointed out that the freight car situation is of extreme importance from the maintenance standpoint because 25 to 35 per cent more is spent for the maintenance of cars than for the upkeep of locomotives. He ascribed the present difficulty to the fact that during government control only 100,000 cars were purchased and practically none retired, while, normally, in this period the roads should have bought 550,000 cars and retired 600,000. While the bad-order cars on individual roads range from 6 to 15 per cent according to reports, Mr. Pickard expressed the opinion that a thorough inspection would show 30 to 40 per cent in bad order. Many cars now in service should be retired, particularly those with short draft timbers and with center sills cut to allow the bolster to pass through. He brought out that some roads have good facilities for repairing freight cars, while others are poorly equipped. To improve the bad-order situation, each road should contribute its share to maintaining the cars. He mentioned the damage to cars resulting from impact at excessive speeds as an important cause of damage to freight equipment.

J. E. Gordon (N. Y. C. & St. L.) mentioned the damage resulting from improper loading and G. J. Charlton (D. L. & W.) advocated the employment of inspectors at loading points to insure the observance of the loading rules. T. A Ward (N. Y. C.) brought out the fact that 7 per cent of the loss and damage claims are due to defective equipment.

Interchange Inspectors and Car Foremen Meet

Discussion of Revision of Interchange Rules and Paper on Transfer and Adjustment of Lading

METHODS for increasing the efficiency of operation and expediting the movement of cars were the keynote subjects at the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America which met at the Hotel Windsor, Montreal, P. Q., on September 14, 15, and 16, 1920. The attendance was probably the largest at any convention of the association; the two hundred railroad men who registered represented railroads and private carc lines in all sections of the United States, Canada and Cuba.

The first session was opened on Tuesday morning by President J. J. Gainey, who called upon Captain A. Layman of the Salvation Army for the opening prayer. Alderman J. P. Dixon; representing the city of Montreal, then welcomed the convention. T. J. O'Donnell, replying to Alderman Dixon, expressed the thanks of the members for the cordial reception and the pleasure of meeting in the Dominion of Canada, for which the people of the United States have such a kindly feeling. He also touched on the importance of the work of the association in caring for 2,500,000 freight cars and 60,000 passenger cars and creating uniform ideas in regard to interchange on all American railroads.

J. J. Gainey (Southern)
President

E. Pendleton (C. & A.)
First Vice-President

A. Armstrong (Atlanta, Ga.)
Second Vice-President

J. C. Keene (Bradford Draft Gear Co.)
Secretary-Treasurer

Address of President Gainey

Following Mr. O'Donnell's response, President Gainey spoke as follows: Mr. O'Donnell has expressed my wishes all the way through and has left very little for me to say. I am glad to see as many ladies and gentlemen present as we have here this morning. I really did not expect so many to come on account of the long distance to be traveled. You all know the object of our meeting. It is printed on our invitations, and the most important part of that is "National harmony and unity of action, everywhere by everyone." If all the members of the association live strictly up to that, it will make our work each day less laborious and more pleasant.

The report of the secretary-treasurer was read and sent to the Auditing Committee, after which the reading and discussion of the paper on Transfers and Adjustments of Lading for Mechanical Defects was taken up.

Transfers and Adjustments of Lading for Mechanical Defects

BY J. M. GETZEN
Ass't Chief Interchange Inspector, Buffalo, N. Y.

"Money expended for productive labor is an asset, but when used to correct omissions and errors is a debit against the railroad paying it and the country as a whole." Under this standard, I wish to open up the discussion on transferring bad order cars and adjusting loads.

Acknowledging the necessity for transferring cars, we have an even division between unavoidable failures and misjudgment of selection of equipment. Among the former we may class: 1. Failures of inherent defects. 2. Failures through accident. 3. Failures through switching. In this category we must allow for natural causes: parts of cars will break, accidents will happen and our friends, the switchmen, will break up their quota of cars no matter how well regulated the organization may be.

In the latter class are: 1. Cars loaded in defective condition. 2. Cars unfit for bulk or high loading. 3. Cars too large for road clearances. We might go on indefinitely with reasons but from my observations most failures are comprised in these three and involve the carman mostly.

The judicious selection of equipment for the load it is fit to carry, is today the most vital means to reduce transfer, repairs and kindred troubles of the carman. The shortage of freight cars in practically every line of trade and its ever increasing demand seem to incline toward skimping on the general repairs and for this reason we must take the car as it stands, and here it lies in our power to classify it properly and prolong its life and usefulness.

To illustrate this clearly—there is not a time when we go over the cars but we find some of them plenty good enough for coarse freight, loaded with grain, leaking through ends and sides, the door post held in with a brake lever bolted through the sill, and adjoining it a first-class box car carrying barrels of oil or tar that had sprung a leak and ruined it for future high-class loading.

Another example is a twisted and contorted 50 ft. furniture car loaded 4/5 full of lumber. It was never designed

Chief Interchange Car Inspectors and Car

for this purpose and will not carry such a load safely. Generally speaking such are our transfers for body defects and hand in hand with it, cars loaded in defective condition. I do not think it necessary to enumerate the specific defects on truck or body that embrace such cars as we hew close to the rules. I might say, go a little better in repair rather than take advantage of the rules. May I not inject a compliment here to our private car owners, especially the packers? Never in my experience have we operated better equipment carrying the highest class freight we know of than we are at this time and they deserve the compliment unstinted.

Next we shall consider the adjustment of loads, and may I not pronounce this the most aggravating byproduct of carelessness? The greatest number of failures occurs unquestionably on house cars—"bad load at side door and door out"—due to no doorway protection in violation of Rules 1700 to 2908 of the Loading Rules covering the loading of various commodities in house cars. Why this should continue year in and year out is a mystery only partly solved and I am leaving this as a question to see if your experiences correspond with ours in trying to overcome the difficulty.

Open loads have the greatest inclination toward distress and too much care cannot be exercised in properly staking, wiring or blocking such loads. Most prominent are stone, pipe, spars, lumber, machinery, etc. Long hauls, and terminal switching dislodge such loads with even the best of blocking and if our shippers could be educated along the lines to secure their loads for sway and motion, much of our trouble and their own complaints would be overcome.

Automobile shippers, working with a committee of the A. R. A. have solved their troubles by religiously following their recommendations and their bad loads are practically zero. Why cannot the other shippers follow their example? Perhaps they have not yet realized that a little initial expense expedites their freight, keeps the car out of the repair track, and reaches the customer quicker and he is more satisfied than if delayed and damaged en route.

Transfers and adjustments converted to dollars and cents mean in our association that we pay between ourselves approximately $25,000 each month to correct these omissions and errors, and while this figure appears large, the number of transfers and adjustments is nominal for a large terminal, the percentage being 23 cars transferred out of every 10,000 handled and 6 adjustments out of every 1,000 cars handled. We are keeping this percentage low only through most extraordinary efforts of our car foremen repairing everything within their power under load.

In conclusion, I want to add the appeal of our operating departments in their efforts to bring the car mileage up to 30 miles per day and lend our efforts toward this end by correcting as far as possible such errors by education and observance of the rules as they are given us.

Discussion

F. W. Trapnell, (Kansas City, Mo.): Mr. Getzen stated that a majority of the foremen were bending every effort to repair everything possible under load, in place of demanding a transfer. We are working along the same line. Everything that can be repaired under load is repaired, thereby obviating transfer and delay of the load incident thereto, with the claims that will accrue from the transfer by the change in the number on the bill of lading; whether there is any change to the contents or not, it will come and the railroad company will have to pay it.

E. R. Campbell, (Minn. Transfer Ry. Co.): In Minneapolis we transfer between 400 and 500 cars a month and in the Twin Cities probably 150 or 200 more. Most of our transfers are due to defective draft rigging and sills on open cars. At the Minneapolis transfer we have the large dray cars and we transfer and adjust loads. We aim to repair everything we can under load, especially commodities like automobiles and pianos, or anything of that kind. We have spent as high as $40 and $50 to repair a car and avoid a claim, because if we transfer a car of automobiles there is always a claim. We have spliced sills and put in new sills and draft rigging in that class of cars.

On the adjustment of loads, especially merchandise, nobody seems to pay any attention to door protection. We get all kinds of cars out of Chicago and I never saw a car loaded with merchandise that had any door protection. A car will come from us and go to Chicago and then there is a claim for door protection. In the milling district, all cars loaded with flour or feed are well provided with door protection and taken care of, but notwithstanding that, when they get down east, sometimes there is a claim for no door protection.

J. E. Vittum, (Columbus, O.): Most of the roads at Columbus, Ohio, repair their cars. I think that since we have the run repair or transfer system, the roads have been educated to make repairs on a larger measure than before, and those who have shop equipment, are making repairs to most of the cars offered in interchange, where the load has to be either adjusted or transferred. However, some of the points in our interchange are limited in their equipment and are unable to make the repairs as easily. I believe in the past two years, half of the cars that were formerly transferred because of defects are now repaired, and we have few transfers on loads at the Columbus interchange.

T. J. O'Donnell, (Buffalo, N. Y.): The paper that Mr.

Foremen's Association of America at Montreal

Getzen presents, is from everyday life. If we can eliminate any part of the $23,000 or $25,000 a month and put it in the treasury of the different railroads, we are doing our duty. You would be surprised to see the number of bad loads that we force the yard department to switch into the repair tracks every morning. There are at least three or four hundred and with the shortage of labor and transfer help, we switch them in with the feeling that they ought to load right at the initial point. If you are going to start a house car with two tiers of oil or vinegar, put in three or four cooperage boards to protect the doorway, because the center of the load will be up against that door and you will have to do it. Three dollars at the point of loading will be better than $5 or $20, or a wreck and loss of a life on the way.

We have been hammering at this for 20 years. The shipper ought to be made to put it in, or the railroad ought to be told for its own benefit; we will allow you the money that costs. The Interstate Commerce Commission told us that it is the duty of the shipper to protect his load. We ought to get this before the proper officials so it will have the desired effect.

I am wondering if it is a better investment to repair cars under load where you have a standing force and transfer platform, than to transfer them. You cannot repair a car under load as well as you can one that is empty. Are we patching up a lot of these sills to get the load through at the expense of the car? It is an open question whether you should transfer a car and repair the empty right when it is convenient to do so.

A. J. Mitchener, (M. C.): When I came to this division in May, we were transferring from 50 to 80 cars a day at a small point, Victoria. The average for the last three months is down now to 48. The repairs that we make to cars embrace the splicing of the center sill, draft timber and end sill, etc. We do not agree on some of the repairs, but as I look at it, it is easy for the repair track foreman to walk down a string of cars and mark transfer on them, but if you put a car on the transfer track, it sometimes takes a week; while you can repair the car under load in 10 hours. The foreman at Windsor couldn't agree with me on repairing cars under load, so I took 22 cars to St. Thomas, and agreed that if I repaired all of those cars under load, he would repair all of those that came after, and he is living up to his word.

A. Berg, (N. Y. C.): We handle the business on the line that has been outlined by those who have spoken before. We avoid transfer as much as possible, though it is permitted at Erie under the same conditions as at other points. It is the desire to avoid claims, and it is necessary to repair under load on account of the transportation department being unable to furnish men to transfer cars, but I do not believe it is a very good plan because we are not able to give the cars the attention that they should receive; especially is that true of the 60,000 lb. capacity cars. Another detrimental feature brought about by the new rules is, on account of the high rates that are paid, we studiously avoid making any more repairs than are absolutely necessary to keep within the expenditure. It is rather deplorable.

P. J. O'Dea, (Erie): During the past two years my activities have been directed almost exclusively to work in connection with valuation for governmental purposes. There seems to be a consensus of opinion that the number of transfers and adjustments are becoming less, and it would be interesting if we had some thing to base that on. Whether it would be worth the labor that it would entail is, of course, another question. In almost every field the number of transfers and adjustments in later years have been very much less than formerly, and that is due to the fact that the equipment, generally speaking, is better than it has ever been before, which is due largely to the activities of the interstate commerce inspectors.

Much stress has been laid on this question of getting cars home, and that is predicated, I think, on the assumption that if they get them home they will get everything that they should get to make them right. My own observation is that the cars usually receive at the hands of the other fellow just about as good quality of repairs and as extensive repairs as they receive on their own home road. Everybody will acknowledge that money spent for transferring and adjusting is not productive. It is a waste of money. The car is not made any better, conditions are not made any more favorable, and it affords the shipper an opportunity of setting up a claim that he might not otherwise make.

C. W. Maddox, (C. & O.): Several years ago we transferred and connecting lines transferred many against us, but we have noticed a decided improvement in the last two years. It has been our practice to educate our foremen and let them use their own judgment as to whether a car should be repaired under load or transferred. We can splice the sills, put in new draft timbers and end sills in dump cars, and make such repairs as can be done just as well with cars under load as empty. Cars in that condition, I think, should be repaired rather than transferred, especially of late years when labor is so scarce. But good judgment should be used. I think some will attempt to repair cars under load that cannot be given the necessary repairs to go to destination. It would be well for us all to watch the condition of cars very carefully when deciding to make repairs under load.

E. H. Mattingley, (B. & O.): I want to agree with the

remarks of Mr. Maddox in regard to making repairs under load. There are certain commodities loaded in box cars which oftentimes cause a car to be made bad order and the defects cannot be repaired under load as well as when the car is empty. For example, splicing of sills. Oftentimes where a sill has been spliced by the method employed while under load, you will find the holes for the bolts are made large enough to slip the sills, which in my mind only means that the car will carry the load to its destination and possibly result in elongated bolt holes, resulting in split sills, which is no remedy of the situation at all. If you can repair properly under load, do so; but if you cannot make a car safe and serviceable, transfer.

In my mind the solution of the whole matter is to get the load properly loaded at the initial point. To accomplish that result a good plan is to have some one familiar with the territory call upon the individual shippers. In some cases you will meet with the response that other roads will take the cars regardless of the loading. By having a chief joint inspector, representing all the roads, call on the shippers, we can get results. In the Youngstown district of the B. & O. with four or five roads, each road represented called at the various shippers pertaining to steel shipments and obtained fine results. By concentrating your efforts in that regard, I feel that you can better the situation.

W. F. Westall, (N. Y. C.): I believe if we follow the practice of the B. & O. and let shippers know that cars are being sent out of their plants which do not comply with the rules, it would be well. We often find that the shippers do not know that the cars are being delayed because of transfer or readjustment, on account of not having proper door protection. If that is taken up at originating points, I think it would better conditions. In regard to loaded freight cars and cars equipped for conveying oil, the only way that can be improved is to get the cooperation of the operating department as soon as the cars are parked.

M. W. Halbert, (St. Louis): We transfer 3,000 or 4,000 cars a month in the St. Louis district. I find a great many of them are transferred on account of not having proper facilities to make repairs. Every car should be repaired under load that can be put in proper condition. I also find that when the mechanical department has charge, there are a great many cars repaired and run that are going to be transferred when the transportation department has charge of it.

T. J. O'Donnell: Do you want to stand here and say that we are bluffing, we are crucifying our own jobs?

M. W. Halbert: When the car foreman has charge of the transfer of bad order cars in our district, he is responsible for the transfer. He gets busy and looks into the bad order situation; if he can repair a car he will do it. If it is set over on the transfer track and the transportation department has a gang of men transferring, he will transfer everything.

T. J. O'Donnell: Who is responsible for the transfers?

M. W. Halbert: The car inspector.

T. J. O'Donnell: Then isn't it our duty to see that we repair every car we can rather than disturb the load?

M. W. Halbert: Certainly it is.

T. J. O'Donnell: Then why do we say to our superior officers that we would have less transfers if they gave the work to us? One of our superintendents met me the other day in the yard and said: "We have turned our work over to the car foreman. We were getting congested with transfers; we will have about a third as many. I want you to give me a record at the end of 30 days how it works out." He had four less transfers and 80 more bad loads.

M. W. Halbert: When you put it up to the car foreman he is going to get busy. The inspector will mark a car for transfer, and the car foreman would not have a chance to look at all the transfers; perhaps they are 8 or 10 miles away, but in our district, when the car foreman gets busy on the transfers he is repairing cars and running them. He is railroading them through.

F. W. Trapnell: In our territory on some lines the car department takes care of the transfer, and on other lines the agent contracts for the transfer. We find that where the car department absolutely has the transferring of cars under its own jurisdiction, there are less transfers than when the superintendent or the agent has the transferring. Some of our connections are a long way apart. An inspector inspects a car and gets it for transfer; that car may be five miles from the car foreman. It is marked in on the transfer track and the agent starts in to transfer. When the transfer is placed with the mechanical department we will have less transfers than we have got today.

T. J. O'Donnell: A general car foreman should work on a mutual basis with the chief interchange car inspector. When a car inspector in a terminal yard condemns a car, he is not through with it. That car passes in to the repair track. It is up to the chief interchange inspector to see that that car isn't tampered with if it can be repaired under load. If you are going to leave the transfer of cars to the car inspectors you would be congested all the time.

F. W. Trapnell: In our report of the country there is a long distance between the repair track and the transfer track and the interchange tracks, and the man at the interchange tracks makes disposition of the car to the best of his ability, and it goes to the transfer track for transfer, and it isn't within ten miles of the foreman, or the general foreman. If he has to make a special trip that ten miles every day of course that is a different proposition. You have got a rather good supervisory force that we would consider could be done away with in our part of the country.

President Gainey: I agree with Mr. O'Donnell absolutely. I claim that the mechanical department is wholly responsible for every car that is transferred, whether it transfers it with its own force, or the transportation department transfers it. In Cincinnati our terminals are about 22 to 25 miles apart. In each large terminal we have a chief inspector. We have an inspector who goes through the entire yard the first thing every morning to see what cars the interchange inspector marked during the night. He examines these cars, and if in his opinion a car can be repaired, or is safe to run, he sends it to the repair track. Only cars that have to be transferred are sent to the transfer track. I cannot see why it cannot be done in every terminal in the United States. We transfer less cars coming from connecting lines than any road in the United States. We have gone as low as 15 cars a month, and we get the same cars going and coming that the other fellow gets.

In the last three or four months our transfers on all roads in Cincinnati have run higher than they should have run, and we have arranged for all the general car foremen of Cincinnati to get together and go through the entire terminal yards, and inspect the work of the inspectors, not saying anything to the inspectors of the time they are coming, and see whether the chief inspector who passed last on these cars is living up to what he is preaching. There have been more cars transferred against the C. & O. and the L. & N. and the Southern than on cars coming from the north. That is not due to the cars.

As Mr. Maddox has said, we repair 50 per cent of the cars under load. If a car is loaded with any commodity that you can splice the sills and nail the floor, you can do it just as well as you can empty and save the cost of the transfer. Every one of you knows that the transfer of cars is a waste of money, both for your company and the company that has delivered the car to you. I do not know of anything in railroading that will save more money for the railroad company than the stopping of transfers.

W. J. Stoll: At the large interchange points where a

chief interchange inspector is located, I do not see why any argument could arise when the general foreman and the chief inspector and his force cooperate. At our point we do not issue any transfer orders against any road unless we either see the car before or after it is transferred and by doing that, if one side transfers more cars than the other side, and we allow it, we are the fellows who are to blame.

A Member: I would say that the transfer of cars is on the increase. The paper that was read brought out the conditions about as we have it, while we have no statistics to back it up. I do not think anybody would be guilty of allowing a transfer if it could be repaired under load.

W. P. Elliott (Ter. Ry. Assn. of St. Louis): The transfer of cars not only should be charged to the car department, but they should have the transferring of loads under their jurisdiction. I know positively that you can reduce transfers. I know that in the Buffalo district and in the Chicago district there are cars being transferred today that could be repaired. We find a lot of cars are being transferred for lack of facilities to make the repairs and a lot are being transferred because the car foremen are sending cars to the transfer track on account of bad order condition. The result was to place the transfer of cars in the hands of the car foremen who were confronted with the problem of getting these cars transferred, as well as getting cars for the transfer, and we find it offsets his desire to shift the responsibility. If the matter is followed up closely by the car foreman, or the general foreman, as the case may be, it will eliminate a lot of transfers. Don't forget that the human element enters into it. There isn't a man here who won't sweep his own dirt before he will his neighbor's.

A. J. Mitchener: On June 10 we had 49 cars. I know we moved the cars. There were 49 cars waiting for transfer. In four days we repaired 46 of them. I am keeping a record of cars transferred against us by connections and I would be ashamed to hand a car back to a man for transfer for the small defects that they transfer against us.

W. P. Elliott: I want to substantiate everything Mr. Halbert said and I want to express my thanks to Mr. Getzen for the paper.

Secretary Keene: I move you that we close the discussion and tender a vote of thanks to Mr. Getzen for the valuable paper.

The motion was seconded and carried.

Tuesday Afternoon Session

At the Tuesday afternoon session the secretary read communications from F. H. Hanson, F. W. Brazier, F. C. Schultz and A. Armstrong.

F. W. Trapnell: I move you that our secretary be instructed to acknowledge these letters and telegrams by telegraph.

T. J. O'Donnell: While we are checking up our old friends let us not forget Henry Boutet and Stephen Skidmore. Let us send them a telegram, for they were really the bulwark of this association. (The motion was unanimously carried.)

The convention then proceeded to discuss the changes in the A. R. A. rules.

Changes in Rules of Interchange

Rule 2, paragraph 3. Loaded cars offered in interchange must be accepted with the following exceptions:

Section (c). Cars improperly loaded (not complying with the loading rules) when transfer or rearrangement of lading is necessary.

Cars loaded in excess of the maximum of Column A table under Rule 86, which is the total weight of car and lading on rails for receptive dimensions of axles shown.

A Member: Our practice at the present time where cars are transferred going home, is that they are sent home by the receiving company, so that a car can move home without any heavy repairs, if the car will go back.

T. J. O'Donnell: If we transfer a Burlington car against the N. Y. C. have we a right to return that car to Chicago?

W. J. Stoll: If the car is safe to go, yes.

T. J. O'Donnell: We had a car in our district that was home 80 miles from where we transferred it. It happened to be on a road doing business for two lines jointly. They said they would not take that car home; that we should get the receiving line to bill it home. I appealed to the officers that it was a reciprocal arrangement, that we could return empty cars from 1 to 300 miles providing the road connected direct with the owning road.

W. J. Stoll: That can only be handled locally by the officials of the different roads. It is a good arrangement.

M. W. Halbert: If the car is to be transferred and it does not belong in the St. Louis district we hold the delivering line responsible. If the car belongs in that terminal, it doesn't make any difference what the condition is, we send it to the home line, but otherwise a foreign empty car after transfer is returned to the originating line.

T. J. O'Donnell: Suppose the car belonged home 100 miles away, in defense of the road that transferred it, wouldn't they deliver it?

M. W. Halbert: They would not. It would be fair if we could get the roads to handle it that way. Under our arrangement, the trunk line handling the car will have to pay five cents a mile also per diem to get the car home. The line that did not originate it, isn't going to haul it home for nothing. The originating line will have to make disposition of that car.

T. J. O'Donnell: Wouldn't you recommed that that be done?

M. W. Halbert: Some of the roads will take it but if a car is out of commission why should any direct line haul it home for nothing? They never get a load haul out of it. But if we can make arrangements with the owners or the handling line and bill the car and get five cents a mile, we can handle it.

A. Herbster: In Chicago a car, even though not belonging to a Chicago road, and held by a road not connected direct, can be delivered to a road that has direct connection in order to get the car home. That has worked out very nicely. The Chicago district has been relieved of a great many bad orders, and I think the thing to do, even though it isn't as the rule reads, is to recommend that it be done universally.

T. S. Cheadle (R. F. & P.): Suppose road A delivers to road B a car loaded with a commodity which can be handed on to road C. The car isn't fit for any other commodity. They didn't bad order the car but permitted it to move through to destination. Possibly two months after, the car comes back; should that car be received back by the delivering line? Suppose no record was made of the car at the time it was received, but inspection showed that the same condition does exist.

C. W. Maddox: If a car is delivered and has to be transferred, and it does not belong to the receiving line, it should be returned to the delivering line for transfer.

A. Herbster: At the large interchange points they are not handled that way. If this thing works out all right at the large points, it certainly ought to work at the smaller interchange points where they have a chief joint inspection bureau. I believe it is good policy to get a car home and get it fixed up rather than holding it a year or two.

M. W. Halbert: During the war we handled the bad order situation as we had a mind to, and in St. Louis we had no congestion because any car was home wherever it was. We could start a bad order over some line and get rid of it, but today it is different. If the transportation department would leave it to us, we could handle the proposition very nicely; we could give and take, but some roads say "We won't haul that car 500 miles unless you pay us five cents a mile, or repair the car." If you get a car in that condition and can put it in condition to be loaded for

any kind of freight, it is a serviceable car, according to the rules. If you can get a load for the car and make it fit to go over the other fellow's line, you can start it, but an empty car, you cannot pass along unless you pay the road for hauling it.

Valentine Blatz (Wheeling): I fail to find anything in the A. R. A. rules stating that the smaller interchange points are governed by the action of the large interchange points. If we interchange a car and it is transferred for certain defects, there is no other way except to return it.

F. W. Trapnell: I move you that it is the sense of this meeting that the proper interpretation of that rule is, where a car is received by a road in bad order necessitating transfer of the load, that the car when empty be returned to the delivering line. (Motion seconded.)

M. W. Halbert: I think there ought to be a little added to it: A car home in the terminals will be sent to the owner.

F. W. Trapnell: I did not mean it that way. The car service association does not intend it that way. If I have a New York Central car and am connected with the Erie, in lieu of turning it back to the Erie, I give it direct to the N. Y. C. to save switching.

The motion made by Mr. Trapnell was carried.

T. S. Cheadle: Suppose the car was received and was not marked bad order. We get stock cars with pig iron delivered to another road. It is defective for a stock car. No record was made of it. Do the rules require that a record be made of it? Suppose it is loaded with watermelons and unfit for anything else.

T. J. O'Donnell: Then the car is traveling on its right. The physical condition showed that the car was such that it would carry the load.

T. S. Cheadle: It was fit for the load going up but it would not be fit on another line.

A Member: The car might not be fit for grain, but you could utilize it for something else.

Mr. Elliott: The reverse might happen tomorrow. These things are reciprocal, as I see them.

President Gainey: If I delivered to you a car to which you took no exception and you had it two months and returned it to me in bad order I would tell you to take care of it.

A Member: Under Rule 2, the car must be accepted back if in the same condition. We had a car loaded with coal with the dump door boarded over, delivered back with the boards gone. They put the boards back on and delivered it back to us in the same condition.

J. M. Getzen: The gentleman bringing up this question has failed to protect himself, in accordance with paragraph J. He admits it was defective when he got it. It was a trap door missing and boarded over. If he had put on "Bad order. Return when empty," it would have come back without any trouble.

C. W. Wolfe (Southern): Reduce the two months to two days. Could you tell him to keep it?

President Gainey: Not for two days. I will agree with you.

C. W. Wolfe: You cannot give it back unless you put a card on there, or make a record.

President Gainey: But he says he has no record of any defect when the car was delivered. He takes it and keeps it for two months and then brings it back and gives it to the delivering line.

C. W. Wolfe: I followed that for a long time but I made up my mind I would make a notation of it.

T. S. Cheadle: I confined myself entirely to the second paragraph of Rule 2. I am trying to see what the application of the rule is where the movement of one class of lading is through your line over to another line, and the car is moving back. The condition is the same, and if loaded with the same commodity it would be all right. The car isn't fit for anything but that class of loading. If you had to make a report of it you would write the initials and numbers of the entire train of 80 cars and would delay the shipment. It seems to me that this rule can be applied as written in the second paragraph when it is on its home route, and that it should be received regardless of whether any record was made of it.

W. A. Rogers (P. & L. E.): As I understand it, it is a question of a car received in interchange, without any records taken as to its defective condition; that car, if moving backwards in home routing, must be accepted if in the same physical condition as when forwarded under load, whether empty or loaded. If I accept a car under load without any objection, the car is mine. The only way you can get rid of that car is, having a direct connection with the owner, or the car being in the same physical condition that you took it under load. You cannot deliver that car back in defective condition simply because you failed to protect yourself, providing it isn't moving on home route. If you get a car under load, you can deliver that car back empty if in proper home route, providing the record shows that your first receipt of the car is also your home route record.

T. J. O'Donnell: Isn't it a fact that we must have 30 or 40 per cent empty mileage? We cannot get loads all the time. We get 50 cars of watermelons. They are loaded on light cars without doors. We cannot load them over the road that gave them to us. We deliver them and I never hear about it. The car service department is utilizing these cars to take steel and coal. We have got to get our empties back to the mines. We are taking cars every day and if a car is delivered within a reasonable time the inspector never raises a question. The empty goes back the same as the load came up. We have got to stand by the handling of the car.

W. A. Rogers: In the Pittsburgh territory we have one road that is congested with bad order cars. They have taken it upon themselves to procure home route record, starting that car on a 2, 4 or 8 months' record. I say that the receiving road accepting that car under load, hauled that car to its destination, and if they find that car at the end of its destination is not fit to carry another load, I don't care whether it is chip baskets or steel, it is up to them to take care of the car. That is A. R. A. rule No. 1 which states what repairs you are to make on the foreign car while on your road. Why return it?

W. J. Stoll: A few years ago you all remember the Master Car Builders put their foot down on running cars under defects. If a defect exists on a car that the delivering line is responsible for, put on a defect card. Rule 2 clearly says that when a car is received by a receiving road with damages and takes its load to its destination, the delivering line must receive the car back.

W. A. Rogers: If in the same physical condition.

G. Lynch (Cleveland, O.): I am puzzled to know what the talk is about. If it is a loaded car offered in bad order in Cleveland, if the owner of the car is in Cleveland we return it to the owner. If it is a foreign car, we return it to the delivering line. If it is a car of melons off any of the southern lines and it is in bad order, we return it to the delivering line when empty. There is no trouble about this thing and I don't know what all the talk is about. It is a case of living up to the rule, as I see it.

W. A. Rogers: We are not talking about a car in the immediate vicinity of interchange. We understand that you can turn a car over to the delivering line or owner, if you have direct connection. We are talking about a car that goes forward without any exceptions being taken, and at the end of perhaps 400 miles it is found with defects. The railroad says it will start it back on a home route record. Are you going to take it with a couple of center sills split? If it was fit to haul a load to its destination, it is fit to

haul a load back. I do not believe in hauling defective cars all over the country; I believe in repairing them.

G. Lynch: The question is not the application of the rule as it is being discussed. If a car moves through interchange O. K., as far as the receiving line's records show, and it returns in a defective condition, after traveling for a week or a month, the delivering line has no right to accept the car. At least they can refuse it. The original receiving line is obliged to take the car back.

M. W. Halbert: The A. R. A. rules are plain enough. I cannot concur in the resolution passed. The rules say you must accept the car under load under certain conditions. It says you must return the car back to the delivering line in its same general condition. Here is the car that Mr. Stoll had reference to with the side posts rotted, the line that delivered the car was duty bound to run the car. Why penalize them simply because they forwarded the car with a load in it? If you try to pin down the delivering line on the bad order equipment you won't get any where. If you take a bad order car under load, with owner's defects, I do not mean defects that originated after the car was received, and when you get one of those old boats that will carry a load to its destination, why penalize the handling line, when you bring it right back; give it to the delivering line and say "Take care of that car." We have a lot of old cars in the St. Louis territory that belong elsewhere and we are trying to get rid of them. We cannot get any railroad to move them unless we pay for the haul or repair. Some of them you cannot repair under A. R. A. prices and make a first class car out of them. The way I look at the resolution, it is going to tie us up. This gentleman says after you get your car it is yours to do what you want to with it, but you are penalizing the fellow who takes it under load with its defects, after he accommodates you by hauling the load to destination and getting rid of the load. Why penalize him because he did not have any record of the car?

W. A. Rogers: It is in the same physical condition.

T. S. Cheadle: I move you that it is the sense of this body that the condition of the car may be established by actual inspection at the time the car was offered back, to determine whether it is in the same condition as received.

F. A. Donahue: Who is the judge?

W. A. Rogers: The receiving road.

Rule 4

The committee recommends that the second paragraph of this rule be modified in accordance with the proposed form shown below:

Proposed Form.—Rule 4, (second paragraph). Defect cards shall not be required for any damage so slight that no repairs are required, nor for raked or cornered sheathing, roof boards, fascia, or bent or cornered end sills, not necessitating the shopping of the car *before reloading*.

A Member: If you receive a car that is damaged and reload it, it is your damage.

T. J. O'Donnell: Suppose we get a Burlington car with 25 sheathing boards missing. The Burlington takes it and makes the delivering line card it; what are you going to do?

F. W. Trapnell: Come back to you.

T. J. O'Donnell: I don't want the delivering road penalized.

F. W. Trapnell: If the Burlington repairs it, the delivering line is responsible.

T. J. O'Donnell: How are we to know what they are going to do? We can simply pass it along if we see it is not cardable without any thought of the afterclap. The refrigerator cars have to be carded.

F. W. Trapnell: And when they get home they always find defects we couldn't see and we always take it up and get the proper protection.

T. J. O'Donnell: Cut out carding unless you feel that the repairs are necessary at the time you card it.

T. S. Cheadle (R. F. & P.): Are the H 1 and H the only convertible freight car valves?

President Gainey: Those are the only ones. Suppose a foreign car when delivered had an H triple in place of a K triple; what would you do with it?

G. Lynch: We wouldn't do anything; let it run.

F. W. Trapnell: Where a non-standard valve is applied to a car that carries a standard valve, should a defect card be issued on the interchange track at the time of the delivery of the car, or, in accordance with our former practice, should it be on the basis of the joint evidence of improper repairs penalizing the party that put the wrong valve on, and not the delivering line? I think that might be on the basis of joint evidence of improper repairs.

G. Lynch: It isn't a cardable defect in interchange. It is a matter for the repair track, the same as wrong repairs; a defect card should be issued and attached to the car at the time the party made the repairs. If the car is coming home to the owner, then I would furnish joint evidence. If it is a foreign car to the receiving line, I would not.

P. J. O'Dea: Isn't it the intention to protect the owners on this high-priced valve, the same as on steel wheels?

G. Lynch: Rule 4 covers wheels, hose, and brake beams. Some lay great stress on the fact that the car is stenciled. We find a similar question in regard to substitution of the 5 by 7 with a 5 by 5 coupler. No one would issue a defect card in interchange. It is the same with the question we are now discussing. It is a cardable defect at the time the repairs are made. On interchange it is not.

President Gainey: I think you are absolutely right. I do not think it is a cardable defect in interchange. If it is a car coming home, it is a joint evidence card you want. If it is a foreign car you do not pay any attention to it.

Rule 32

The committee recommends that Section (d) of Rule 32, be modified in accordance with the form shown below:

Proposed Form.—Rule 32, section (d). Collision, or impact other than that occurring in regular switching, *such as:*

(1) *Misplaced switches.*
(2) *Wrong or misinterpreted signals or failure to observe signals.*
(3) *Letting cars get away on incline.*
(4) *No rider protection when necessary.*
(5) *Coupling on with locomotive at speed exceeding limits of safety.*

The committee recommends that the last paragraph of Rule 32 be modified in accordance with the proposed form shown below:

Proposed Form.—Rule 32 (last paragraph). Defect cards shall not be required for any damage so slight that no repairs are required, nor for raked or cornered sheathing, roofing, fascia, or bent or cornered end sills, *not necessitating* the shopping of the car *before reloading*, the receiving line to be the judge.

T. J. O'Donnell: In discussing this rule Mr. Goodnow said that the committee had given it much thought and this was the best rule they could give. I cannot see any reason why we should not accept this and let it work itself out for a year or so. If you get a car with the sills broken and end all gone, you do your duty when you ask the man on paper how the damage occurred. If he tells you that it occurred in ordinary train service, take this literally.

F. W. Trapnell: Mr. Goodnow, chairman of the Arbitration Committee, gave us to understand that this rule would require more clerical work on the large interchange lines; and you would have to get after the superintendent and trainmaster to give you this information, but we find that the switchman and engineer get into a little trouble and they cover it up. They break a car in two and the switchmen make the statement that it was done in ordinary handling, and the engineer corroborates it. In investigating some of the cases we went to a car foreman and he gave us his side of the story; the trainmaster had no record of damage to the car. It looked peculiar that so much damage would occur to a car in fair usage, so we went up to the engineer and told him what we knew about the case and asked him what he was doing. It developed the fact that the road handling the car was responsible instead of the owner of the car. We have got to get to the bottom of each case and find out that we are not placing repairs on the car owner that should be assumed by the handling line.

G. Lynch: Rule 32 is perhaps impossible of enforcement

on the repair track or interchange track. While I agree with Mr. O'Donnell that it makes it easier for him or me, or any other joint inspector, we could get no information by investigation. We have tried that and the only proof we get is that they don't know. It is a loss of time and impractical to investigate such cases. There are all steel, modern cars that are all shot to pieces. They have not been derailed; consequently the owner is responsible. I have in mind certain private line cars, some have 15-in. center channels with a top and bottom plate, all broken. There is no redress because there is no proof of the car being derailed. The rule, in my opinion, should be rewritten; we might even go back to a combination or limit the damage beyond which the owner would be responsible just so long as we have this go-as-you-please handling of cars that the war brought on with liberal rules, or no rules at all.

T. J. O'Donnell: I want to bring out to offset what Mr. Lynch said that out of 12 cases we had, 5 of them admitted that the delivering line damaged the cars through unfair usage. That is a fair percentage. I cannot help believing that they will be honest enough to admit it. We ought to try the rule out. I think the A. R. A. is going along in a liberal way. We have only had 12 cases in a year. Our officials are very plain. If they have a car in a wreck and send it home they say "We had this in a wreck. Give us a card."

W. J. Stoll: The fact that the handling line is not penalized may not reduce the bad order cars any. My understanding of Rule 32 is that there is supposed to be a more rigid investigation made as to how the damage occurred.

T. J. O'Donnell: You know when you wreck a car and when you don't. When you are in doubt, investigate the case. I do not think we will have any trouble with this rule.

A Member: I don't quite understand the rule. Is there any other damage that could occur in a collision or impact outside of those designated in Articles 1 to 5 inclusive? For instance, switching from both ends of the track or throwing a cut of cars down into another switch would be an impact or a collision, but it is not designated in the five items.

F. A. Donahue (C. & O.): Was not Rule 32 put in force for the express purpose of making the man who had a weak car strengthen it?

C. W. Maddox: The only thing we can do is to use good judgment. I think we can tell whether a car has been damaged in fair usage, and if we find a car looks suspicious we can ask the yard people what information they have. I do not see how we can make any improvement in it.

T. S. Cheadle: We discussed this rule for about three hours last year, and finally somebody said it would have to be left to the man on the job. I am very much of the opinion that we should do the same thing this year.

W. A. Rogers (P. & L. E.): I believe you will have to take a car and if there is any controversy about it the owner will have to take it up with the delivering line.

J. C. Burke (Mo. Pac.): If you get one of your own cars home, how are you going to decide that the damage is done in rough handling?

T. J. O'Donnell: Get it from the operating officials of the road that you delivered from.

J. C. Burke: The delivering line would say, "No rough handling on our line." I take it for granted it would be the same in all cases of this kind. If the evidence isn't there to show that the car has been roughly handled the chief interchange inspector won't be able to decide.

T. J. O'Donnell: He will decide there's no unfair damage and make you do the work.

Rule 43

The committee recommends that the following note be added to rule 43:

Note—In the case of damage to more than five longitudinal sills on wooden underframe cars, more than four longitudinal sills on composite wooden and steel underframe cars, more than three steel longitudinal sills on steel or steel underframe cars and both steel center members on tank cars with two steel longitudinal sills only, the company on whose line such damage occurred must furnish owner statement showing the circumstances under which the damage occurred, if it is claimed that the damage was the result of ordinary handling. This statement, in the case of cars reported under Rule 120, to accompany request for disposition of car, and in cases where it is not necessary to report car under Rule 120 to accompany the bill for repairs.

The committee recommends that, in view of the foregoing note, the first interpretation of Rule 43 shown at the top of page 54 of the 1919 Rules of Interchange, be eliminated.

G. Lynch: Rule 43 is a twin brother of Rule 32. If the Arbitration Committee had stopped at the word, "Only," the rule would be a good rule, but unfortunately they continued on, and spoke of ordinary handling. I take the stand that a steel underframe car of present day construction cannot be damaged to the extent of buckling the sills or breaking them in ordinary handling. I do not know what the definition of the term "Ordinary handling" is, as referred to in this rule. That is something we should get defined. As it is, we do not know what ordinary handling is, and we do not want to report half the damages and hold up the car for an indefinite period. I would recommend, at the proper time, that Rule 43 conclude at the word "Only."

President Gainey: Do you say steel sills cannot be bent under fair usage? You see many a car buckled under fair usage.

G. Lynch: It is the definition of the term that is perplexing. What do they mean by "Ordinary usage"? Or "Fair usage"? My interpretation of both of these sentences would be: Judging from the condition of the car, I would say it was something more than the ordinary that did that damage. That is the only way that I could get a definition of the term. I cannot refuse to accept my own car for repairs, regardless of its condition, but this rule would give me a line on just where the responsibility would be placed. As it is now, we do not know where it is.

W. J. Stoll: In my opinion the rule is all right. If you break five sills you make your report accordingly, and if you break three sills, you make another report. The man who damages the car is to furnish a statement.

W. P. Elliott: When four or five sills are broken and nobody knows it, what is to be done when the car gets to interchange?

W. J. Stoll: The fellow that handles it is supposed to give a statement.

W. P. Elliott: They don't know. These cars are damaged in the middle of the yard.

W. J. Stoll: Cars don't derail automatically.

W. P. Elliott: The damage happens, and the car comes in interchange; I have the car, and am going to repair it. How am I going to give a statement that I don't know is true?

T. J. O'Donnell: You had better call a conference with all of the officials in your district and put that up to them, and tell them that beginning September 1 this rule will be in effect. You must have these statements and closer supervision when damage is done. Appeal to those that you are working with. Show the switchmen the amount of money that it means to your railroad, and that is all that you can do.

J. M. Getzen (Buffalo, N. Y.): I think Mr. Elliott is working under adverse conditions, for the reason that he is obliged to take a foreign car in interchange. If in his own mind he is satisfied that the damage happened in ordinary service he can repair the car. If there is a doubt in his mind he has a right to demand protection from the delivering line.

T. S. Cheadle: The chief joint inspector represents the line that delivered the car, as well as the line that received it. He could, in my opinion, handle that by knowing the exact condition of the car, but where there is no chief joint inspector it seems to me that Mr. Herring is right. The joint man should be in a position to get a statement from the delivering line as to how that damage occurred, before he could put it on to that line.

W. P. Elliott: We are taking a great many cars from other lines; he would have some job.

T. S. Cheadle: He has to handle them with a clerical force. We are not honest with the other fellow if we don't, because if the chief joint inspector passes them out to a place where they have no chief joint inspector he has got to pass it.

W. A. Rogers: Is it the consensus of opinion that a car with such defects as outlined in Rule 43, if offered to the owner, would be accepted as owner's defect, and so passed upon by the chief joint inspector?

A Member: Yes.

W. A. Rogers: If there are no reports coming to the owner he will have to get it. An owner would get the car home with six sills broken; the chief joint inspector is the boss and the owner must accept it. If he would investigate and find that the delivering line damaged the car in switching, without a written statement of some kind, then what?

W. J. Stoll: The only thing we can do is to ask the delivering company or the handling line if they had any wreck or derailment.

T. J. O'Donnell: We have 7 out of the 15 that we demanded.

President Gainey: I agree with Mr. Herring. For example; the Southern delivered a Big Four car home with five or more broken sills, and he cannot specify how the sills were broken, who is responsible?

T. J. O'Donnell: Have you refused to accept it as owner's defect?

President Gainey: It is a penalty put on the delivering line for not saying how that car was damaged. If he can show that that car had six sills broken by dropping it over the hump or shifting a cut of cars, he furnishes the desired information, but in the absence of furnishing any information he takes the responsibility.

W. A. Rogers: You're getting in deep water. There is no evidence of that car being in a derailment. There are six sills broken and that is an owner's defect.

President Gainey: If the B. & O. cannot furnish evidence how these sills were broken it is responsible for the six sills.

A Member: What are you going to do with the car?

Answer: We ask the B. & O. how it happened, and for a card for six broken sills.

W. A. Rogers: Is the chief joint inspector going to issue the defect card on the spot, or wait two months?

President Gainey: He will give you a chance the same as on a joint evidence.

A Member: Suppose the car was damaged between the terminal and the place where the chief joint inspector is located and nobody along the delivering line knows that the defect existed until the chief interchange inspector finds it at the terminal, when it is delivered home and he says it is owner's responsibility; who is responsible if all of the sills are broken?

President Gainey: The delivering line is responsible if there are five or more sills broken if it cannot show how the car was broken.

W. A. Rogers: Are you going to issue defect card?

Answer: Yes.

M. W. Halbert: I think we should live up to the instructions of the Arbitration Committee. There is one thing I don't like and that is the investigation. I think under the volume of business we do in St. Louis it will be difficult.

President Gainey: Suppose a wooden car was delivered from one railroad to another in your territory, with five or more broken sills. If the car was going home, in the absence of the man delivering saying how this damage occurred, what would you do?

M. W. Halbert: I would make a personal investigation, and show my common sense, and if I thought the delivering line was responsible, I would say so. If the car owner, I would say, "Take your medicine." You have got to make a decision. There are no two of us going to interpret the rules the same way. We have got to interpret them according to the defect on the car. That is the only way I see that we can get by. We might make a mistake once in a while, but I think the majority of times you will do right.

President Gainey: If a car was delivered home by a connecting line with five or more broken sills and the delivering line could not furnish the evidence, who will be responsible?

G. Lynch: The owner.

President Gainey: Why do you say that? The rule says that the road breaking those five or more sills must furnish you the evidence.

G. Lynch: I would ship the car to the home line and if the delivering line that damaged the car failed to make a report to the owner, the owner would pay. I have no report to make of the car to the owner or to the delivering line.

President Gainey: You passed the car, who's going to be responsible?

G. Lynch: The car owner; there's no evidence of derailment or side-swiping. I don't see any other way out of it.

J. C. Burke: If the owner has received his car home, and the inspector called to make an inspection and there are six sills broken and he knows that it is damaged from one of the five causes, under Rule 32 would he issue a defect card?

G. Lynch: Yes, if I knew that that car was damaged by any of the five items, even if it had a broken coupler, if I knew personally how the damage occurred, no investigation is necessary.

Thereupon the meeting was adjourned until Wednesday morning.

Wednesday Morning Session

President Gainey: Is there any further discussion under Rule 43?

T. S. Cheadle: I think it is a question whether a defect card can be issued under Rule 43. Can the line receiving the car demand a defect card under the rule as written for more than three sills without any indication or cornering or side swiping? At interchange points where there is no chief inspector, if a car comes home with five or more broken sills, would a defect card have to be issued?

T. J. O'Donnell: The receiving line naturally would look for protection, and I think time could elapse to find out how the damage occurred. I think the handling line would protect the owners in their own way, or arrange with the receiving line to take it home.

W. R. McMunn (N. Y. C.): The idea with some chief inspectors at interchange is that it will delay the car seriously in taking the matter up where we have questions as to how the cars were damaged, although in our district we have very little trouble. It is either a case of giving a card, or taking it up with the delivering line, to find out how the car was damaged. Out of 15 cases we gave cards for about 7; the rest were all owner's defects.

T. J. O'Donnell: I do not think that our higher officials want to be drastic against any equipment of that nature. The idea is this: The managements of these railroads in the last 10 years have spent millions to put their equipment in such condition that it will stand the severe handling that the motive power causes at this time. Is it fair for you to pay $3,500 for a good 40 or 50-ton car and then permit somebody in another section of the country to pay $1,200 for a wooden underframe car to go all over the United States and Canada and protect him on the service that that car is obliged to take with a heavy steel underframe car? If his car does not stand the ordinary service it is his duty as owner to bear any expense unless the car is derailed. It is a just rule and I think we ought to sustain it in its entirety. The big trunk lines of this country have spent millions of dollars to keep the equipment up to standard. If some see fit to maintain

a lower class of car, they should be perfectly willing to maintain it by the roads billing them for any expense to handle it. When the sills are broken in ordinary handling I think the owner ought to stand for it.

For that reason I move you that it is the sense of this body that Rule 43 be interpreted on the following basis: The handling line, in breaking the number of sills mentioned, if they see fit to repair the car before delivery, must furnish a statement to the owner when they render a bill for the items mentioned, as to how the damage occurred. If they deliver a car in interchange it is their duty to apply a defect card for unfair handling under the rules, and if not unfair handling, they must issue a statement to the receiving line, if it sees fit to repair the car and bill the owner.

G. Lynch: The motion reads that the defect card shall be issued at interchange and then the statement afterwards. That is contrary to the rule. The statement must come first and then the responsibility afterwards. The motion is wrong to that extent as I see it. It is a rule that is impossible of proper interpretation.

The question was put upon the motion and was carried, with but one dissenting vote.

Rule 108

Proposed Form.—Rule 108. No labor to be charged for the inspection of cars, testing or adjusting brakes, adjusting angle cocks, tightening unions, *nuts or lag screws* or spreading cotters; sill steps, ladder treads or handholds, tightening or straightening on car; *brake shafts or uncoupling levers straightened when not removed from car.*

No charge to be made for the material or labor of lubrication, except as provided in Rule 66.

T. S. Cheadle: In regard to nuts tightened, in case draft bolts are loose and timbers down, and the bolts are tightened, are you entitled to charge?

President Gainey: If you make the card read "tightening draft bolt" you are. I would like to ask Mr. Stone on that question which is proper.

C. C. Stone (Southern): A charge against the owner would not be proper for tightening draft bolts. Rule 107 starts off and says "Labor charge shown unless otherwise specified." Rule 108 specifies no labor charge for tightening nuts. You cannot tighten a bolt unless you tighten the nuts.

T. S. Cheadle: It is undoubtedly a just charge to tighten up draft timber. It often requires considerable work and it is a protection to the owner's car. The rule does not provide for a labor charge for it.

President Gainey: No, but it says "Tightening bolts."

T. S. Cheadle: It appeals to me that it would be a legitimate charge.

President Gainey: It says "Tightening bolts 3/10 of an hour." You cannot tighten a bolt without tightening the nut, and if you tighten 8 or 10 draft bolts on a car, I claim you are entitled to a charge according to Supplement 3.

Mr. Barton (B. & O.): It all depends on the manner in which you make out the repair card. If you put on the repair card that you tightened the draft timbers, I think you will get away with it without argument.

Restenciling G. E. T. Cars

W. M. Herring (Southern): I want to ask with reference to restenciling G. E. T. cars as to what charge has been made. Of course the instructions specify that the charge will be in accordance with the A. R. A. rule, but I wondered if anybody had kept account of the actual cost. I had the matter up with Mr. McManamy to see if we couldn't increase the present amount on account of it being inadequate.

Mr. Barton: We kept account but after taking it up we found they were going to stand strictly to the rule.

W. M. Herring: Mr. McManamy said if we could justify it, he was willing to make it right; that he had heard of several roads making the same request. There was only three or four out of a hundred that asked for an increase in price.

President Gainey: Are you all charging in accordance with the rules and have any of you taken it up with the government to increase that charge?

W. M. Herring: It costs us around $3.50 and I asked if it could be put on the basis of time for reweighing.

President Gainey: Where you get the car out in the yard, you have to send the painter out there or put the car in and you cannot do it for the price, unless you take it for reweighing and restenciling, and then you can get pretty close to it.

W. M. Herring: Mr. McManamy said they had to comply with A. R. A. rules and he couldn't see why we couldn't restencil a car within the limits allowed on Rule 160. I told him that the nature of the work was different from stenciling a car to preserve its identity. I promised to give him something more definite as a reason. Of course it is a bill against the owner of the car, and they in turn bill the administration.

Maintaining Equipment Standards on Cars

T. J. O'Donnell: I would like to ask if the members are having any trouble on carding for a non-steel wheel under a car stenciled "Steel wheels." We are issuing a large number of cards and we feel that it is an injustice. The cars go through different interchange points and we are careful on the Canadian lines. We have to watch cars closely to comply with the instructions of the Canadian line officials. We receive any number of cars with no card on them. We always take the reading of the cast wheels so we will have the data. We are daily carding cars for steel and steel tired wheels. We find that the defect cards apparently have been removed that have been on the car. We also find when we card these cars against the delivering line that the mechanical department has traced and found that the car was carded prior to coming to our territory. The cards are removed by some one. We have sometimes blamed our inspectors, thinking perhaps they do not know what they mean; they would sooner tear it off than take the reading of it.

G. Lynch: Our experience in regard to that matter is that the repairing line refuses to put the card on the car at the time the repairs are made. We seldom see a card on a car at the time of interchange, and we are obliged to issue a defect card. That is in keeping with just what Rule 112 will be. No man will put a defect card on for damage. He isn't putting on a card for wrong repairs that he knows positively he made. The time to put a defect card on is when the repairs are made, not when offered in interchange. We have returned to several of the roads defect cards that were issued in error. Sometimes there is no stencil on a car; originally the car may have been stenciled "Wrought steel wheels" but the owner fails to maintain the stencils. We will have cars offered in interchange with other wrong repairs such as triple valves and no defect card is applied. This is also where the motion in regard to Rule 43 failed. I would ask a man when he makes wrong repairs to put a defect card on the car; that is the cure for the wrong repairs.

President Gainey: The rules bear Mr. O'Donnell out in what he is doing. They say it is a cardable defect in interchange. If a car is stenciled "Steel wheels" and it has a cast wheel, it is his duty to issue a card.

W. J. Stoll: Under government control defect cards were not issued, and there were a good many cars equipped with cast wheels that are now coming to the front and we have to card them.

J. E. Vittum: We have a great deal of trouble because of cars which were stenciled and equipped with steel wheels, but due to rust and corrosion the stencil has been eliminated, and we cannot tell by the reading of the stencil whether steel wheels are standard. Some of the roads are refusing, without the stencil, to issue a defect card because the rule specifically says if the car is so stenciled. I would like to know what the roads are doing, whether they generally are refusing to issue defect cards, although well aware that steel wheels are standard to that equipment.

President Gainey: I think the rule is a good one the way it stands. If a railroad spends the money to put steel wheels under a car instead of cast wheels, it should be protected. We have inspectors on all interchange points, and of late years they have had very little carding to do, and that rule should be lived up to strictly. There is no good reason why an inspector should fail to see a cast wheel in place of steel.

A. Berg: Often cars are away so long that they lose their identity. The stencil and everything else is gone. The owner has no opportunity to maintain it. In view of the fact that this condition exists and we have been penalizing on account of the failure of the party that damaged the wheel to comply with the rules, it behooves the interchange inspector to afford protection.

J. M. Getzen: I want to go back to Rule 88. In our district we are receiving home a large number of cars bearing defect cards reading: "One pair of wood draft timbers in place of metal draft arms, labor only." It isn't my understanding that that rule is intended to deprive the owner of charging for labor and material on such repairs when he gets the car back. I would consider such repairs as temporary. The defect card is wrong, in having that item "Labor only."

F. W. Trapnell: If he considered that as temporary repairs and secured a defect card for labor only, he got more than he was entitled to, because it is my opinion that all he would be entitled to there would be the scrap value of the material that was lost. There is a case in the arbitration decisions between the St. Louis-San Francisco and C. B. & Q. When I offered to make settlement for temporary repairs to give them the scrap value of the material that was removed from the car and settle the case, they thought I was wrong. We took it to the Arbitration Committee and they said if it was temporary repairs, all that the Frisco would be entitled to would be the scrap value of the material, and that was draft arms and metal draft bolster.

J. M. Getzen: What I wanted to bring out was, when you place a defect card on a car it is natural to assume that you bill for those repairs. If you have done that you must be billed for the wood parts and expect to get paid only the labor of substituting.

T. J. O'Donnell: Suppose you bill out wooden draft timbers at a point where you have no metal in stock. My idea is that you should charge for your wood and labor. When the owner comes back he should simply charge for his metal draft arms and the changes. We have a right to put in the wood in place of metal, where we haven't the proper material.

A Member: In that case the defect card should read for material.

J. M. Getzen: It is wrong repairs if you are going to bill it. If we are taking away 500 or 600 lb. of steel, it is wrong repairs.

A Member: This rule protects you when these parts are missing and you issue a defect card for the material, but I do not think there is any defect card due you for labor.

President Gainey: Draft arms that extend 30 in. beyond the body bolster cost $150 or $200 a car. We put in wooden draft timbers and send the car home. The owner is undoubtedly entitled to pay for the draft arms that have cost him $100. I should think the proper way would be to card the car "one set of wooden draft timbers in place of steel."

W. M. Herring: We have had a number of cars come in with wooden timbers and as yet I have been unable to find out in any case by whom they were applied. I have received no bill. I have traced the movement of the cars, and the roads say they have no record of having made the repairs. We have also had cars destroyed on foreign lines, and when we sent a statement showing the depreciated value of the car we showed metal draft arms in accordance with our record. The line having the car in its possession at the time of destruction showed that the car was equipped with wooden draft timbers and wanted us to change our statement. We have had the same thing on metal body bolsters. I could find no arbitration decision to cover that. The only way out I can see is to submit it to the Arbitration Committee for a ruling, as to whether a line destroying a car could settle in accordance with the standard, or according to the condition at the time it was destroyed. It does not seem right to penalize the line destroying the car by charging for a metal arm or body bolster when the car was not so equipped; still the owner should get some protection. On all the cars destroyed during federal control, we have received no protection. We have not found a defect card on any of the cars that came home with wrong repairs, either for material or labor, and when we have traced the car back, we have been unable to find out by whom the repairs were made.

W. M. Herring: I think he should be protected on material. Rule 95 will give him that authority.

P. F. Spangler (St. L.-S. F.): The rules set forth the specific items of material which you are required to carry in stock. If you do not have the material in stock and substitute wrong material instead, you are responsible to the owner for the labor and material. If, to expedite repairs, you substitute wooden parts, all you are liable for is the labor and you should attach your card to the car. I often throw away a body bolster and substitute wood, attaching a defect card for the labor only, allowing scrap credit for the bolster removed and bill for the labor and material of the wooden bolster applied. Rule 122 is plain on that.

T. S. Cheadle: Rule 16 says that the original construction of the car must be maintained. If you replace a wrong draft arm in place of the right one, you would only be entitled to the labor. These parts that we have to carry in stock are regular A. R. A. material. I understand it has been done, but it was not the intention to permit you to put wood in place of metal and only pay for the labor.

(At this point the discussion on the Rules of Interchange was closed. The papers presented at the later sessions will be published in the next issue.)

Cars Built This Year.—Statistics regarding the number of freight and passenger cars delivered to the railways of the United States by 23 car building companies during the first seven months of 1920, show that these amounted to 21,000 freight cars and 49 passenger cars. This indicates that 1920 is likely to furnish a new low record for car production. The number of cars on order and undelivered increased steadily since the first of the year, until at the end of July the orders amounted to 50,275 freight cars and 811 passenger cars, the increase being obviously due to the fact that the builders were receiving orders faster than they were turning cars out.

New York Central Motion Picture, "Bulletin 70".—Marcus A. Dow, general safety agent of the New York Central, has brought out a fourth motion picture for use in giving safety lessons to the employees of the road. Unlike "The House That Jack Built" and other films heretofore produced for the New York Central, the present one deals mainly with the startling facts of the railroad accident records of the whole country.

The title of this film is "Bulletin 70," and the story is based on the annual statistical accident report of the Interstate Commerce Commission for the calendar year 1918, which was contained in the bulletin of that number. That record tells of 9,286 persons killed and 174,575 injured on the railroads of the United States in the twelve months, and the details and classifications of casualties fill 30 large pages—not to mention $40,000,000 in money damages. Mr. Dow has been able, of course, only to touch a few of the "high spots" of the record.

A New Method of Case Hardening Steel*

Former Methods Are Compared With a New Process of Case Hardening by Regenerated Cyanogen Gas

BY WM. J. MERTEN

Metallurgical Engineer, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

IRON and low carbon steels absorb carbon from so-called carburizers very readily when in contact with these carbonaceous materials at temperatures above the upper critical point. The quantity of carbon absorbed depends upon several factors. One of these is the temperature or degree of heat above the critical point of the steel. In other words, the higher the temperature, the faster and deeper the penetration of the carbon.

The character of the carburizer is also an important factor in the successful conductance of case hardening including the depth of the case. Elementary carbon as such is only of secondary importance. Oxygen and nitrogen compounds which are added or are naturally present in the so-called energizers are necessary to generate nascent gaseous carburizing mixtures of carbon monoxide and cyanogen gas (CO and CN).

The percentage of carbon present in the steel used for case hardening has also a marked influence upon the affinity of the material for more carbon up to saturation; more specifically, a low carbon steel absorbs faster than high carbon steels.

The presence of chromium, tungsten, or manganese accelerates the absorption of carbon since they form double carbides with the iron. Nickel and silicon, however, retard the absorption. The fact that they form solid solutions with iron may be the cause for this retardation.

From statements made in the second paragraph it is readily conceivable that, if a properly heated piece of steel be brought into contact with pure nascent gas continuously generated in a separate unit or chamber and preferably under pressure, the conditions for case penetration would approach the ideal. A process of this type is the one presented in this paper, preceded by a survey of the processes now in vogue with their disadvantages and deficiencies.

Present-Day Methods of Case Hardening

The most general and commonly used method of case hardening is conducted by packing steel parts in a metal box filled with carburizing materials and firing the tightly closed box and contents at a sufficiently high temperature for an adequate length of time to give the desired depth of case. This process is quite simple and assures fair success if properly conducted in accordance with a prescribed procedure, experimentally determined to give certain definite results under definite and specific conditions.

The disadvantages of the above process are as follows: (1) uncertainty of proper reaction within closed box; (2) difficulty in duplication of results as predetermined, because of non-uniformity of carburizers; (3) long time exposure of the steel to a heat not well controllable, producing a questionable structural condition; (4) high cost of operation because of inefficiency of the heating method; (5) cost of boxes due to rapid deterioration of same by oxidation.

The second method to be mentioned is case hardening by immersing the steel article in a cyanide bath heated to about 860 deg. C. (1580 deg. F.). This process is convenient and effective on small articles only and where the depth of the required case is not more than .005 in. to .015 in., or where mere surface hardening is wanted. This is a fast case-forming method and from 10 to 15 minutes gives the desired depth. The outstanding disadvantage of this process is that no uniform case can be produced. The parts deep in the melted bath do not get the same depth of penetration as the parts near the surface. The evolution of the cyanide gases at or near the surface favors the penetration and it is hardly feasible to have pots with a large enough surface area to take care of the case hardening of a plant.

The third method consists of dipping a cherry red piece of steel or tool into a container of powdered cyanide salt, such as potassium cyanide, sodium cyanide, ferro and ferri cyanides, or sprinkling the powdered salt of these cyanides on the red hot steel surface and putting the steel back into the fire again. The case hardening produced in this way is very superficial. In the fourth method the carburizing gases are passed over a piece of steel heated in a retort. This process is applicable to parts that are intricate in design.

The process to be discussed next, although still in the experimental stage, owing to radical changes in the principle employed, appears to present opportunities for efficiency, preservation of the product, simplicity of operation, uniformity of results, speed of operation, reasonable cost, and wide range of utility. This process may be called a regenerated cyanogen gas case hardening.

Cyanogen Gas Case Hardening

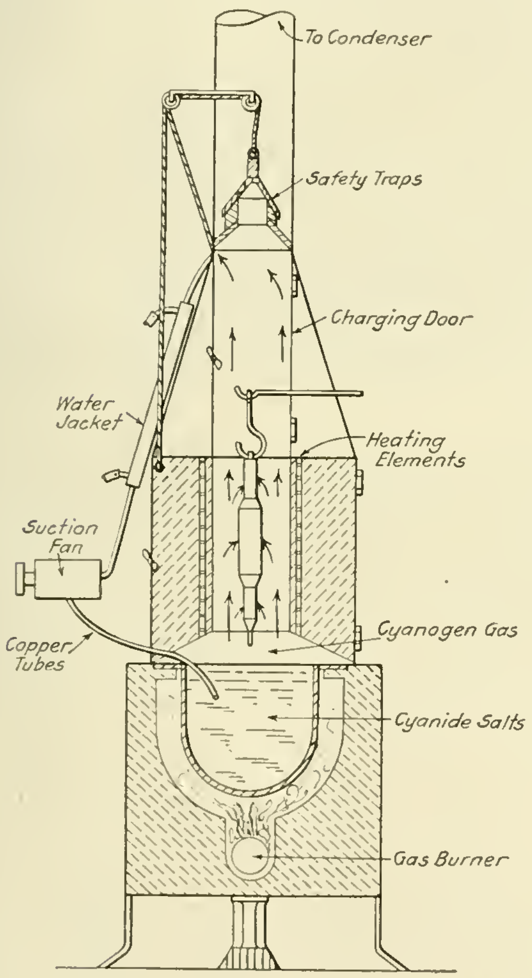
It has long been recognized that the most efficient carburizing gas is cyanogen (CN). The case is of a greater

*Paper read September 9, 1920, before the Pittsburgh Chapter of the Steel Treating Research Society.

uniformity, is more rapidly produced and penetrates deeper than one produced by carbon monoxide (CO), but the highly poisonous character of the substance has been a serious objection to its use. The tendency is to wastefully lead the gas to the stack and out of harm's way, instead of controlling it to get maximum efficiency.

To case harden steel and iron alloy articles in a stream of cyanogen gas evolved from a container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish vaporization or boiling of the salt, is the principle upon which this process is based.

The articles or materials to be processed are independently heated out of contact with the fused cyanide salt. The advantage of this will readily be appreciated on recalling the statements made regarding the fact that case hardening is produced by contact with gaseous and not with solid carbon



Regenerative Gas Case Hardening Furnace

and more especially with cyanogen gas. The depth of penetration is then only a function of the uniformity of the temperature of the article treated and the duration of treatment. Nascent cyanogen gas has a speed of penetration of four or five times that of carbon monoxide.

The furnace shown in the sketch embodies the regenerative principle since the excess gases not absorbed by the steel are forced under pressure into the fused cyanide (CN) bath, are reheated, causing a vigorous stirring of the bath, and a lively evolution of cyanogen gas, leaving with more energy and larger quantities, therefore more vigorously attacking the steel surface, causing accelerated and deeper penetration.

This regenerative type of furnace is a means to use the rather expensive salt economically, as the nitrogen gas on returning will combine with the sodium and a carbon supply in some cheap form such as charcoal can be added to the liquid as required, thereby retaining the original supply of cyanide salt intact.

To prevent the poisonous gases from escaping into the room, the suction fan indicated is shut down before the charging door is opened and a bell ventilating device for inducing draft is arranged so as to open the bell when the fan stops and prior to opening the door.

Parts of the pump or suction fan should be of non-ferrous metals such as copper, basic alloys or hard copper. Water cooling jackets or other protective methods are to be employed for the return flues for hot gases and the nozzle end of the flue must be of hard copper, monel metal or other non-ferrous alloy with a high melting point.

Sodium cyanide melts at 600 deg. C. (1112 deg. F.) and boils at 800 deg. C. (1472 deg. F.). The temperature of the pot must therefore be not less than 800 deg. C. and to effectively absorb this gas the steel is at a temperature above the critical point or about 900 deg. C. (1650 deg. F.).

The furnace illustrated in sketch is a design for the processing of shafts, etc., but a slight modification of the upper or steel heating chamber will adapt it to a variety of work. Grates of nichrome metal with knife edge supports are used.

The advantages of this process are the following: (1) temperature control is more perfect since the pyrometer is inserted directly in the heating chamber; (2) a finer, more uniform, and deeper case can be secured than by any other processes and less time is required; (3) the use and storage of carburizers and carburizing boxes is eliminated.

It should be noted that while some of the less important features of this process are still speculative in character, because of the experimental stage of the development, the method is based upon well known principles and the conclusions have been drawn from a careful study of general case hardening practice.

CARBON AND HIGH SPEED STEEL*

BY J. J. RYAN
Baltimore & Ohio

The forging of tool steel has received less attention than annealing or hardening. Nearly every smith has had more or less experience, but those who forge tool steel as it should be done are scarce. Most smiths think all that is necessary is to forge the article to proper shape and size. They pay little attention to the heat so long as the steel does not fly to pieces.

Occasionally tools are forged at too low a temperature, which is nearly as bad as overheating. Tools forged at too low a temperature will be very brittle, and internal strains are produced which are very liable to crack or spring the tool in hardening. I have seen many smiths who overheat the steel and then hammer it long after all traces of red heat have disappeared. Hammering steel at black heat should not be done under any circumstances.

To properly forge tool steel, have a clean fire deep enough so that the blast will not strike the steel. Keep the steel slightly covered, heat slowly and evenly and turn it over frequently. For a large tool or forging, several heats are required, but it should be finished at a dark red. When the red disappears it is time to stop hammering. When finishing a tool, several heavy blows are necessary to make the steel compact and fine grained.

Good cold chisels, like good steel workers, are scarce. They are the most abused tools in the world. Cold chisels should be made of steel containing from 70 to 80 points carbon. First cut off enough steel to make it the desired length. Heat it to a bright red back about three inches; then trim off the corners on two parallel sides so that the end will have a short, blunt point. This will keep the edges

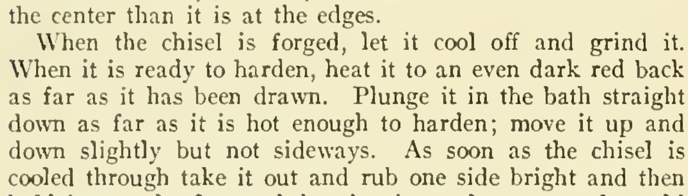
*From a paper read before the International Railroad Master Blacksmiths' Association.

from lapping over in forging. Draw the chisel on the horn of the anvil the first heat and it will not require as much hammering on the edges to get it into the proper shape. The less a chisel is hammered on the edge the better it will be. When it has been hammered on the sides until it is a dark red never turn it up edgeways and strike it. If it must be hammered on the edge put it back in the fire and heat it again, do all the hammering on the edge that is necessary and then hammer it evenly and thoroughly on the sides, but do not strike the edges again. When you get the chisel nearly to size and shape, medium heavy blows are necessary to pack the steel. This should be done when the steel is a very dark red, but when the red disappears, stop hammering immediately. Put the chisel in the fire but do not turn on any blast. As soon as it is a dark red take it out and give it several good blows on each side, then heat again and hammer as before. Repeat the operation three or four times but remember to keep your hammer off the edges. If the chisel gets too wide or the edges get crooked, it can be filed or ground to shape.

In making a flat chisel out of 3/4-in. steel, draw it out so that it will be about 1/8 in. thick at the end, and about 1/4 in. thick three inches from the end. A chisel of this size should be about 7/8 in. or 3/4 in. wide and a trifle thicker in the center than it is at the edges.

When the chisel is forged, let it cool off and grind it. When it is ready to harden, heat it to an even dark red back as far as it has been drawn. Plunge it in the bath straight down as far as it is hot enough to harden; move it up and down slightly but not sideways. As soon as the chisel is cooled through take it out and rub one side bright and then hold it over the fire, and drawing it evenly to a regular cold chisel blue.

A chisel made in this way can be worn back three inches before it needs dressing and the edge will stand far better than the ordinary chisel made like a blunt wedge and hardened about 1/4 in. on the end, as it is generally done.



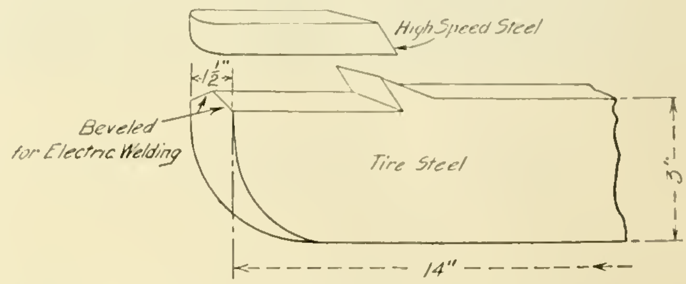
Two Types of Tire Steel Wheel Lathe Tools with Inserted Cutting Blades

This method of forging steel holds good on all flat tools and tools that can be finished on the flat sides, such as side tools, flat drills, cut-off tools, etc.

BY R. W. MILLER
Baltimore & Ohio

We are compelled to be specific in stating what each round, square or octagon bar of tool steel is to be used for. We have about three grades of carbon tool steel that vary from 90 points to 150 points carbon and one high speed steel. This is standardizing as far as it is possible and when we have a furnace for heat treatment of tools equipped with a pyrometer to gage the heat, the tool question is reduced to a science. One man should be placed in entire charge.

None of our car wheel and locomotive lathe tools are of solid high speed steel shanks, as they are forged from tire steel and tipped with high speed steel by electric welding. I have experimented very extensively in welding high speed tips to tire steel and find that the best way is to electric weld them. In using solid high speed steel, after the largest tool becomes too short it is drawn down to the next size that will make the tool long enough without any waste, and so on down until the last operation will produce a piece 3/8 in. by 3/8 in., 2 1/2 in or 3 in. long, to be used in one of our own make tool holders. We save all the cuttings and trimmings, which are reclaimed at the Mt. Clare shops, Balti-



Method of Applying High Speed Steel Tips to Tire Lathe Tools by Electric Welding

more, Md. I know of no other process with less waste. In one year's accumulation we have about 25 lbs. of high speed steel scrap, which is sent to the Mt. Clare shops.

All our large taps and reamers are also made from scrap pieces of high speed steel. The bodies of these reamers are made of soft steel, case hardened, and the cutting blades inserted.

All high speed steel is annealed by placing the steel so that the pieces will not come in contact with each other, in a filling of two-thirds iron borings and about one-third charcoal. This is placed in an oil furnace, brought up to a good heat and left in the furnace to cool as the furnace cools down, about 10 or 12 hours, after which the box is taken out of the furnace and kept in a dry place for about five hours before opening. The box for holding this material is a 12-in. or 14-in. pipe about 18 in. or more in length with a plug in each end and a 5/8-in. rod passing through the box from end to end to hold the plugs in position. The plugs are tapered to draw up tight.

In hardening high speed steel parts a furnace is used for large pieces and a forge, bricked up to retain the heat is used for small pieces. The parts are quenched in linseed oil, moved up and down, not in a circle. The 3/8-in. by 7/8-in. by 12-in. blades warp a little but are forced into their seats in the reamer and are peened with a hammer to make a good fit. A collar at the top end of the reamer keeps the blades from being forced upward in using the reamer.

Our large tire lathes are equipped with tire steel holders of the type shown in the drawing, with inserted high speed steel cutting parts. We have taken cuts 1 1/4 in. wide and 7/16 in. thick with these tools.

Discussion

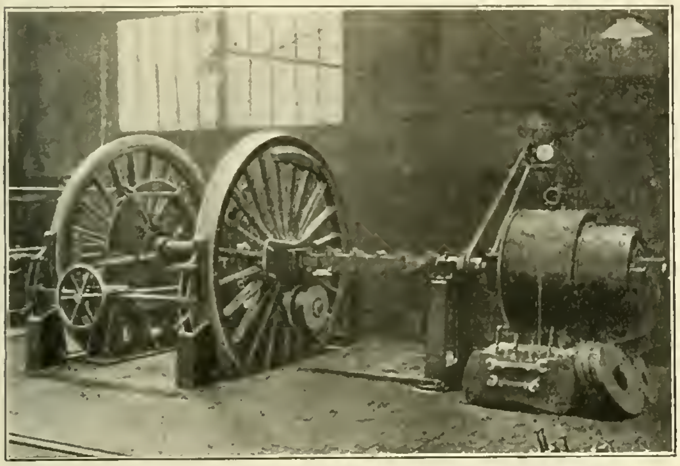
The suitability of open hearth carbon steel for tools was discussed by a number of the members who have had experience with it, the consensus of opinion being that this material is not suitable for tools and that crucible steel should be used.

The methods of forging tools described in Mr. Ryan's paper were generally conceded to be excellent, but a number of the members took exception to them as being too slow to satisfy the demand for output which must be met in railroad shops. A number of instances were mentioned where chisels are dressed under small belt driven hammers which make it possible for one man to dress several hundred chisels in an eight-hour day.

Locomotive Wheel Balancing Machine

Device Used in British Railroad Shops Tests Wheels by Rotating Them in Spring Supported Bearings

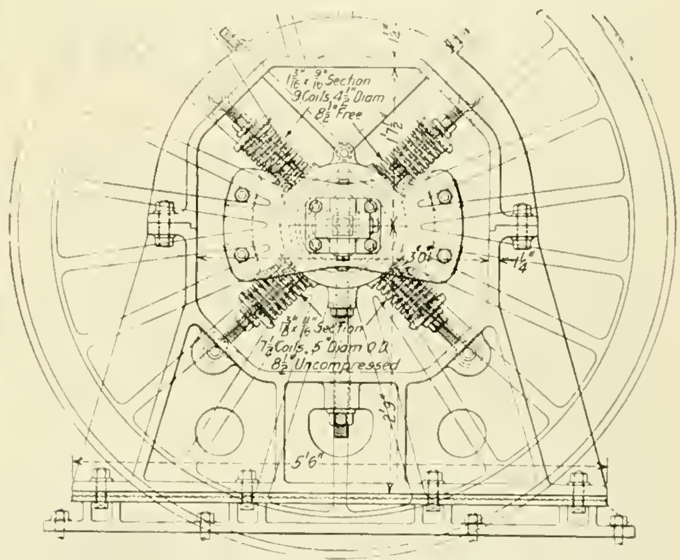
In American railroad shops little attention is generally given to accurate balancing of locomotive driving wheels. Improper balance increases the stress on the rail and on the machinery and causes bad riding qualities. For that reason it seems that the matter should receive more attention. The greater refinement in this respect that is prac-



Balancing Machine Showing Driving Motor and Flexible Shaft

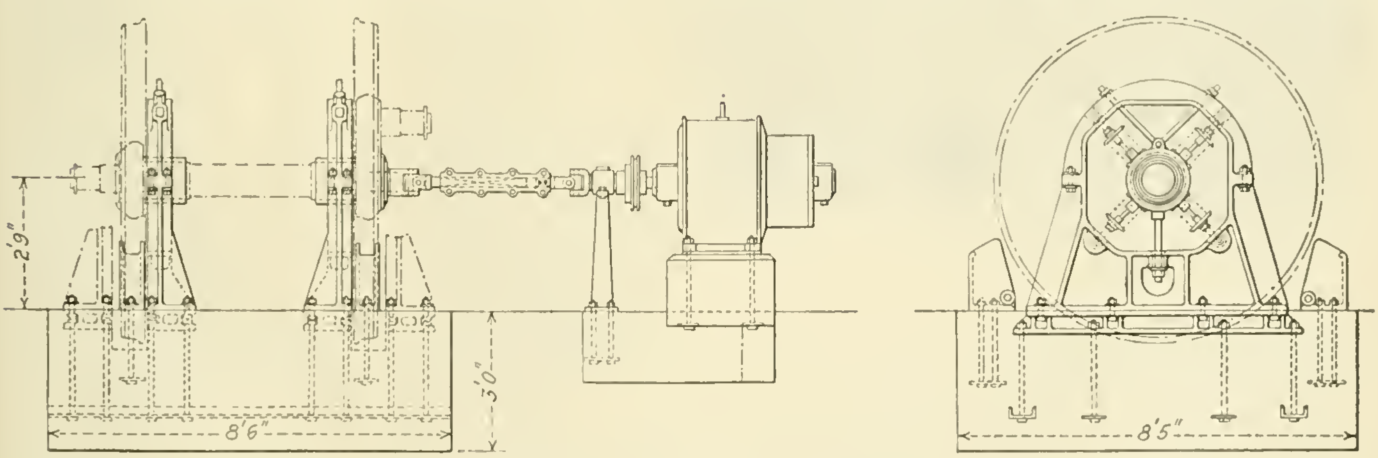
ticed on British railroads is exemplified by a machine for balancing locomotive driving wheels designed by G. J. Churchward, of the Great Western Railway, and described in The Engineer. This machine was first installed at the Swindon shops of the Great Western and since that time has been put in use at Crewe on the London & North Western, and Doncaster on the Great Northern. In commenting on the use of the machine The Engineer states that while the theory underlying the balancing of locomotive wheels is well developed, a locomotive wheel that has been balanced purely by calculation is seldom if ever completely free from the action of unbalanced centrifugal forces when running. The results secured with this machine have demonstrated that all locomotive wheels, however carefully the balancing calculations have been conducted, should be subsequently examined experimentally and adjusted in accordance with the condition shown.

The machine consists of a pair of bearings for the axle, each bearing being supported on four springs so arranged that the bearings may "float" and vibrate with the axle, should the wheels when spun be out of strict balance. As will be gathered from the accompanying illustrations, the bearings and their springs are supported from cast iron frames split horizontally to permit the wheels to be inserted and bolted to the foundations in a manner permitting the distance between the frames to be adjusted to suit wheels with inside or outside bearings. The spring bearings of the ma-



Details of the Floating Bearing

chines are also split horizontally, and can accommodate brasses of different internal diameter to suit axle journals of various sizes. The brasses are bedded not directly against the cast iron external straps of the spring bearings, but against spherically backed brasses with which these straps are lined. Thus any faulty alinement of the bearing brasses or any tendency for them to get out of alinement by a possible whipping of the axle or similar movement can be accommodated.



Arrangement of Motor, Flexible Shaft and Bearings

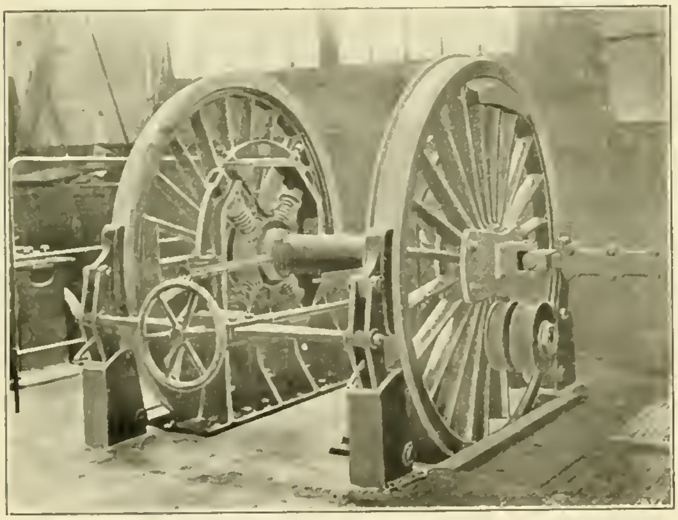
The upper and lower halves of the cast iron straps carrying the bearings are tied by bolts to the upper and lower halves respectively of the surrounding cast iron frames.

These ties, however, are quite loose and are intended merely to limit the extent of the vibrating action without interfering with the early stages of its development. The weight of the wheels and the unbalanced centrifugal forces, if such forces exist, are transmitted to the surrounding frames entirely through the springs.

The wheels are driven by a 35-hp. electric motor, the driving connection being established through an extensible shaft, having a Hooke's joint at each end. The final portion of the Hooke's joint next the wheel is bolted to a plate, which in turn is bolted to the spokes of the wheel. The center line of the driving shaft must, of course, at the outset be accurately collinear with the center line of the axle in order to avoid introducing an extraneous source of vibration. To facilitate the attainment of this condition when the wheels are being set up in the machine, the final portion of the Hooke's joint next the wheel is provided with a spring plunger in the form of a lathe center, and the driving plate is bolted to the wheel spokes with this plunger entered into the center mark on the axle end. A tachometer driven off the motor shaft permits the speed, in miles per hour at which vibration begins, to be noted.

Brake equipment, comprising two brake blocks per wheel, is provided in order that the wheels may be quickly brought to rest at the end of a run. The brakes may be applied either by means of a hand wheel or by admitting air at 90-lb. pressure to a standard 8-in. cylinder.

Before a test is made the small portions of the axle journals projecting clear of the spring bearing brasses are smeared with red lead, and the point of a spring plunger marker—clearly shown in one of the illustrations—is brought within a short distance of each smeared surface. These markers when vibration begins, scrape away the red lead lying



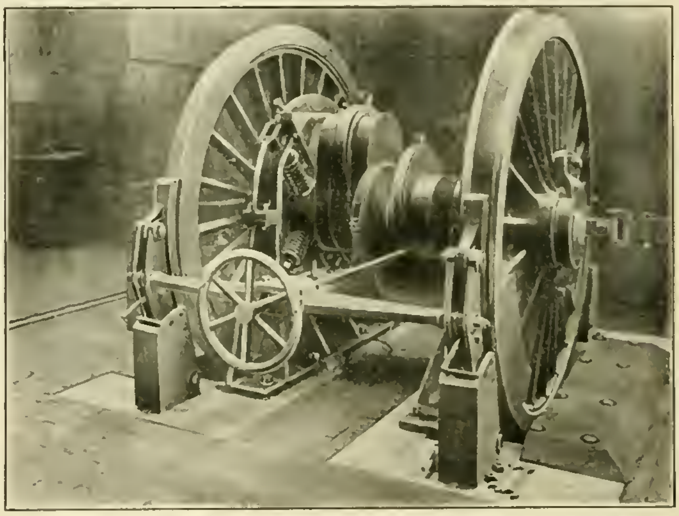
Balance Weights Applied to Wheels with Outside Cranks

towards the radius of the wheel along which the unbalanced centrifugal force is developed.

It is the common practice in Great Britain to take the revolving masses plus two-thirds of the reciprocating masses, and to regard the sum as the total revolving mass to be balanced. For each type of wheel the calculated amount of the revolving and reciprocating masses to be balanced is represented by a weight or weights attached to the crank pins, the weights in the case of an inside cylinder engine being split and held to the crank pins by means of straps. To secure correct results it is important that the weights representing the portion of the reciprocating masses to be balanced should revolve in the plane in which these masses reciprocate. In the case of coupled wheels, therefore, temporary extension pieces are attached to the crank pins, so that the weights representing the reciprocating masses may be brought out into the plane of the connecting rod, crosshead, piston, etc.

In balancing wheels they are speeded up until they begin to vibrate and are then brought to rest, and a trial weight is bolted to the spokes at a point indicated by the mark on the axle. They are then again brought up to speed, corrections in the counterweight being made until they are in complete balance up to and at the maximum speed. When the correct weight has been found a draftsman determines from its magnitude and position the additional weight which must be added to the wheel to secure proper balance.

To facilitate changes in counterbalances they are cast with pockets or formed from steel plates riveted on each side of the spoke with lead poured in between. The lead is alloyed with antimony, which causes it to expand on cooling and



Balancing Machine with Wheels for an Inside Cylinder Engine

avoids the trouble experienced due to the counterweight pounding to pieces when pure lead is used. It is interesting to note that when a pair of wheels for an inside cylinder engine was run in the machine distinct signs were noted that the crank axle was "breathing" under the action of the centrifugal forces on the balance weights in the wheels. As a result the practice had been adopted of building up such axles with balanced cranks and applying the balance weights entirely to the crank webs and not to the wheels.

Apprenticeship in France.—As a means of providing for the present shortage of skilled labor in France, a law has been promulgated providing for the creation of technical classes for youths under the age of eighteen employed in works and factories. Employers themselves have the right to establish classes for their hands, but where this is not done the classes must be instituted by the chambers of commerce or by professional groups with funds provided partly by the state. There is a general feeling that the state should not be permitted to monopolize the instruction, and employers are, therefore, urged to provide the instruction themselves as part of the technical training of their hands.

Improvement in Screw Measuring Machines.—Dr. P. E. Shaw, of University College, Nottingham, England, has improved a screw-measuring machine, which appears to be simple in construction and rapid in operation. All the movements are sliding, thus greatly reducing the time needed for measuring. One special merit claimed for the new machine is that it is equally applicable to plug and ring screws. There appears no reason to doubt that this claim is correct, in which case a distinct advance in meteorology will have been secured. The accuracy of the new machine is stated to be to 1-5,000th of an inch on diameters, and 1-20,000th on pitches, both in the case of plug and ring screws.—*Scientific American.*

LABOR-SAVING DEVICES ON THE SANTA FE

Aggregate Savings Due to the Adoption of Apparently Simple Shop Kinks Often Are of Great Importance

BY J. ROBERT PHELPS

Apprentice Instructor, Atchison, Topeka & Santa Fe, San Bernardino, Cal.

EFFICIENT shop devices that have worked out well in actual practice in the San Bernadino Shops of the Atchison, Topeka & Santa Fe are shown in the accompanying illustrations and described below.

Clamps Used on Tire Boring Mill

In boring the largest tires for passenger locomotives, it was found a difficult task to clamp them to the boring mill

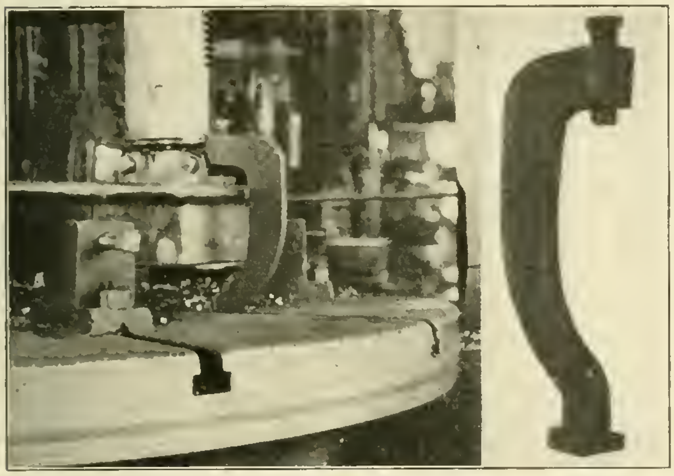


Fig. 1—Clamp for Holding Tires on Boring Mill Table

table owing to their large size. Before making the clamps, shown in Fig. 1, bolts and blocks were used, requiring considerable time for the set-up and not holding the tires firmly. To obviate this difficulty, special clamps were forged with T-heads to fit the slots in the boring mill table, the clamps

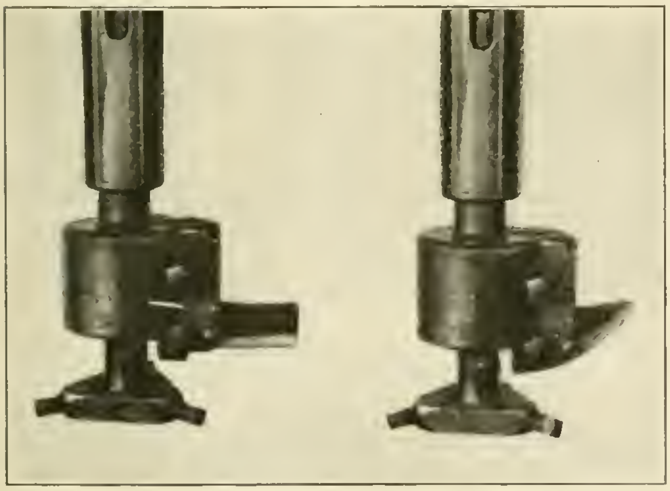


Fig. 2—Jigs for Machining Steam Pipe Joints

being offset to pass around the tire and having set screws for tightening the tire to the table. In setting up on these screws, all the pull comes directly on the tire which is held firmly to the table by six clamps, or as many as may be necessary.

Facing Steam Pipe Joints

At one time in railroad shop practice it was thought advisable to make up all steam and exhaust pipe joints using white lead. Under the action of high temperature steam over a considerable period of time, this white lead acted on the joints to make them very rough. The result was that they often required machining before being ground in and this work was formerly done at San Bernardino on a horizontal boring bar, already overcrowded with work.

To relieve the boring bar of this work, the tool illustrated in Fig. 2 was designed and the machine operation

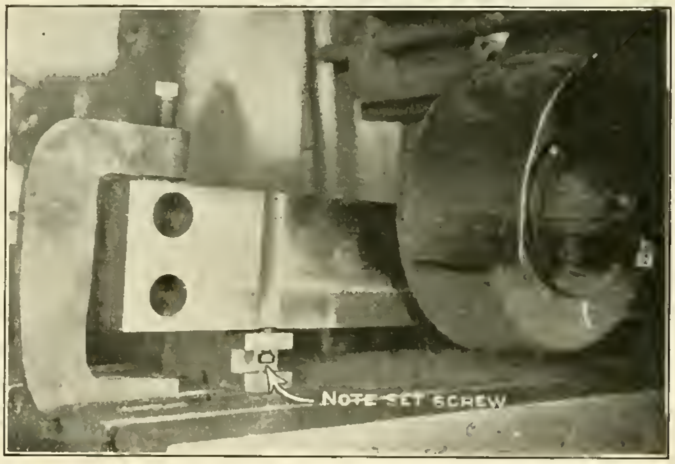


Fig. 3—View Showing Use of Guide Adjusting Block

can now be performed on a radial drill press. As indicated, the tool consists of cutters suitable for flat seats or ball joints, the cutter in either case being guided by a spider or pilot block adjusted to any desired position by the use of set screws. In operation, the spider is set in the steam pipe

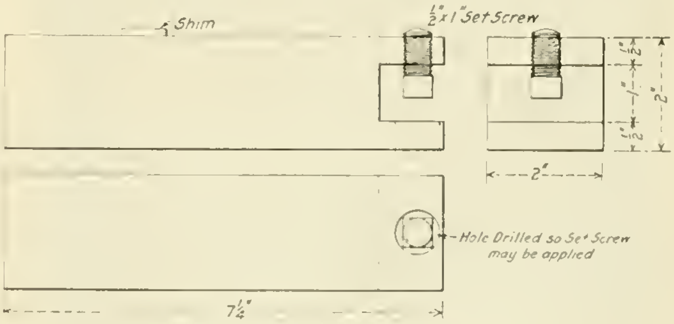


Fig. 4—Details of Guide Adjusting Block

which is firmly clamped to the base of the radial drill. The drill is started and, guided by the spider, the cutter forms a joint quickly and accurately.

Guide Adjusting Blocks

The actual operation of grinding a slightly worn guide takes from 5 to 10 min., while from 20 to 30 min. is often used, tipping the guide one way or the other to get it in position, so the wheel will grind square. The jig, illustrated

in Fig. 3, was designed to reduce this time to the minimum and make it unnecessary to bother with paper shims. By use of the set-screws shown, the guide can be tipped to any designed angle without stopping the machine or loosening up clamps.

Construction details of the jig are shown in Fig. 4. A bar of iron or soft steel, 2 in. square by 7 or 8 in. long, has a slot milled in one end and a hole drilled and tapped to take the ½ in. by 1 in. set-screw shown. In order to permit

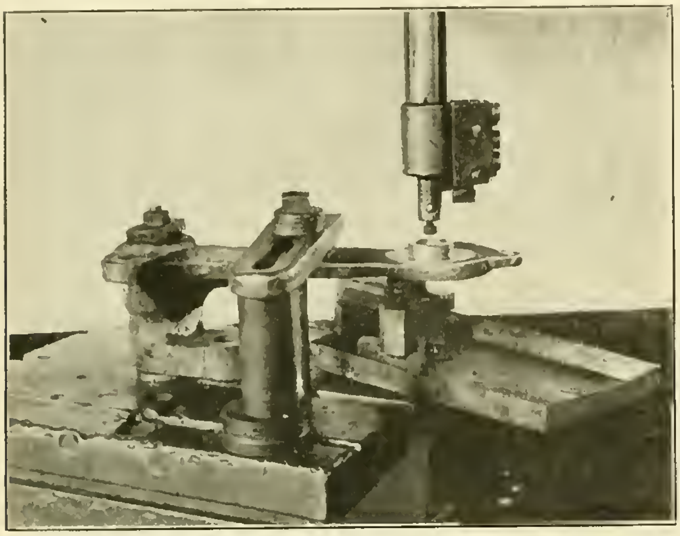


Fig. 5—Tool for Forming Brake Hanger Boss

tipping the guide towards the wheel, the thin shim indicated is provided and may be attached to the jig by electric welding if desired. The arrangement has proved a great time-saver.

Machining Brake Hanger Bosses

A device for holding and a tool for machining brake hanger bosses on all classes of locomotives is shown in Fig. 5. Formerly this work had to be done on a horizontal boring bar,

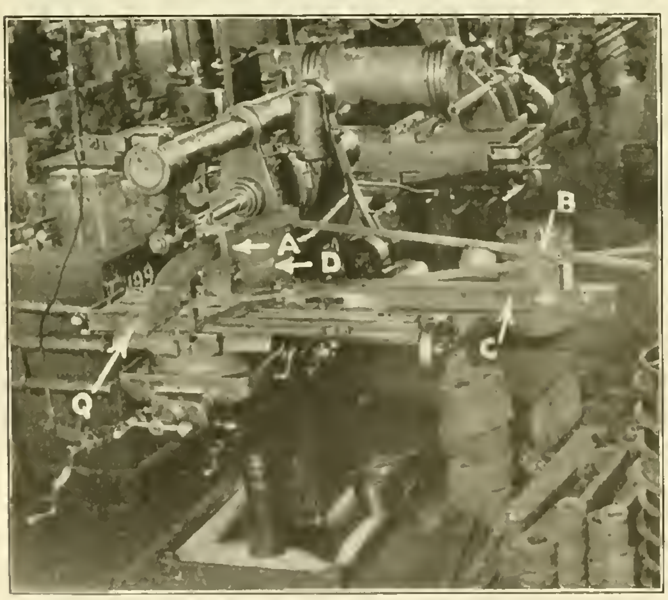


Fig. 6—Jig for Machining Reverse Lever Quardants

but under the new arrangement the operation can be performed on a radial drill press. A hole is first drilled in the brake hanger at the proper place, and the succeeding operations of counter boring, turning and facing are all performed in one operation with the tool illustrated. The arrangement of this tool is plainly shown, and a similar one adapted to the particular dimensions of any brake hanger can be provided. The only further operation necessary after facing is tapping the thread. The time now required for all the above operations is 16 minutes, and with an average of 125 brake hangers machined each month, the total saving in time is considerable.

Milling Reverse Lever Quadrants

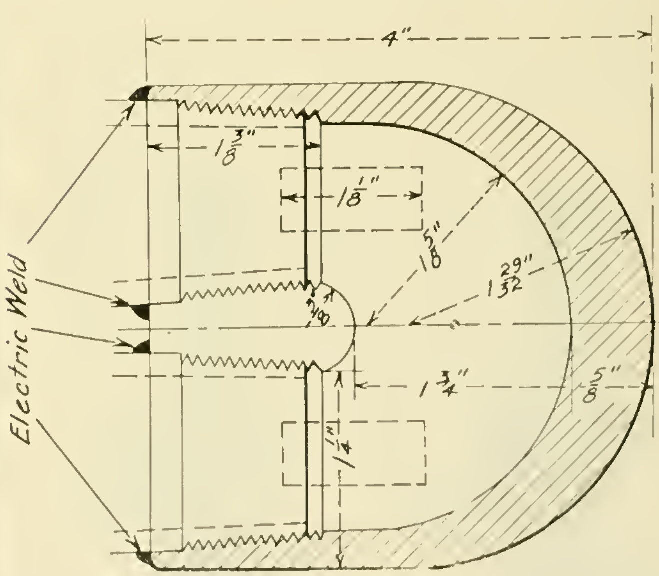
It is common practice in some shops to lay out reverse lever quadrants and later machine the teeth on a shaper or slotting machine. With this method of manufacturing quadrants, considerable time is spent in laying out the teeth, and the work of machining them is both unnecessarily long and non-uniform in results.

To overcome these difficulties the arrangement shown can be used to good advantage. Referring to Fig. 6, the reverse lever quadrant *Q* is supported on the table of the universal milling machine by a quadrant support *A*, being firmly held in place by the set-screw shown. The radius rods *B* are adjusted to the proper length and supported on the extension *C* firmly fastened to the milling machine table. A latch operated by the latch handle *D* is provided at the quadrant support, being arranged to fit into each quadrant tooth, while the next tooth is being milled. The quadrant is thus accurately located for each tooth. By using this arrangement, the radius of the quadrant is correct, every tooth is exactly the same depth, the same distance apart, and all the labor of laying out the radius and teeth on the bench is saved with a resultant decrease in labor cost.

WELDING SUPERHEATER UNITS

BY W. EISELE

The ordinary superheater unit with four tubes and three return bends presents numerous opportunities for leakage, especially in the six threaded connections. Although the return bends are made of high grade steel and the tubes are secured by a taper thread there is considerable



Method of Welding Tubes in Return Bends

trouble from leaky joints. Electric welding where the tube entered the return bend was tried in order to stop the leakage, but it was found after several trials that the weld when cooled and tested was not perfect, due to the unequal expansion of the rolled steel tube and the cast steel return bend. This difficulty has been overcome by filling the unit with water and plugging the open end with wooden plugs while welding. The water reduces the expansion to a minimum and makes it easy to get a tight joint.

Fuel Oil as a Means to Increased Capacity

Critical Boiler Plant Condition Relieved and Efficiency Improved by the Use of Fuel Oil in Place of Coal

BY C. C. LANCE
Shop Engineer, Seaboard Air Line

The Jacksonville plant of the Seaboard Air Line provides power, light, compressed air, water and fire protection to a general shop for repairing locomotives, freight and passenger cars. It is the second in point of size on this railroad and cares for all repair work originating on the southern end of the line.

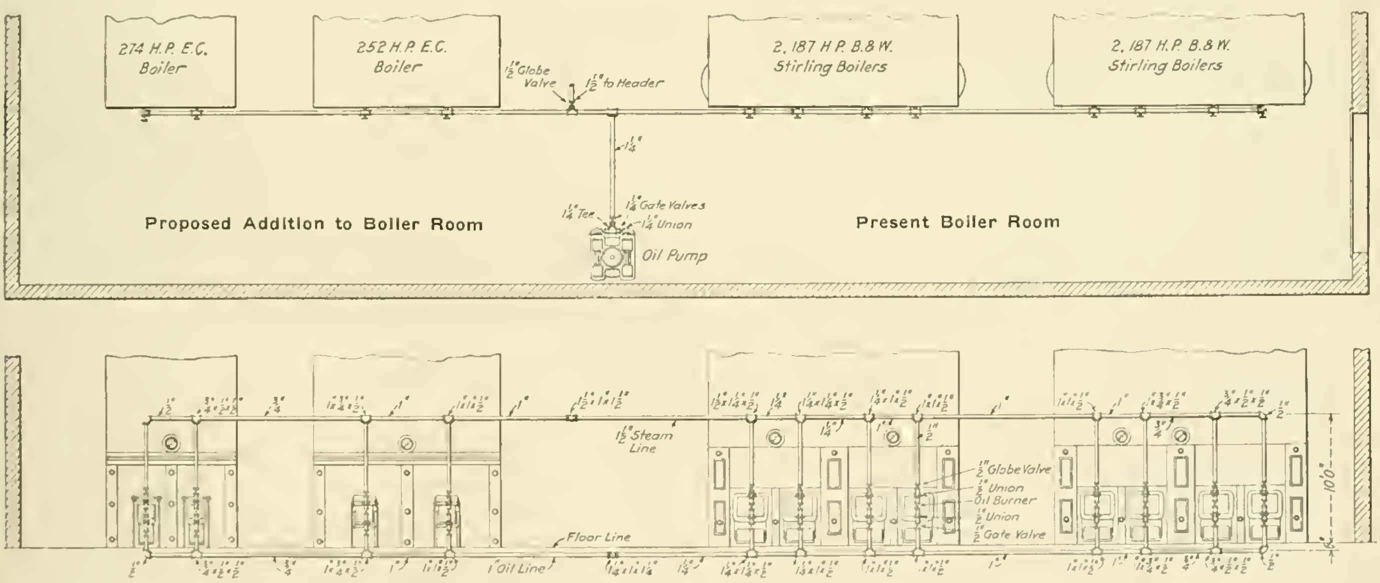
In addition to the shop requirements, power, water and compressed air are supplied to a large roundhouse and all locomotives running in and out of this terminal take water here. The roundhouse has a separate stationary boiler to furnish steam for blowing engines and similar purposes, as on account of the distance from the main power plant it was not considered economical to carry steam that far. When originally built the boiler equipment consisted of three 187 hp. Stirling boilers, arranged for burning coal, hand-fired, each boiler having its separate steel stack. An underground ash tunnel was provided below these boilers, which were provided with ash hoppers that dumped into buckets on narrow-gage cars which were so arranged that they could be dumped by an outside overhead electric traveling crane.

The power generating equipment consisted of two 120 kw. alternating current generators and one 120 kw. direct current generator, each direct connected to tandem compound Erie Ball engines, a 35 kw. direct current steam driven generator and one 35 kw. steam turbine. One 925 cu. ft. steam-driven air compressor and two 500-gal. per minute underwriters' steam fire pumps furnished water supply as well as fire protection. The generating equipment was run condensing with vacuum and dry air pumps, no circulating pump being installed, as the pressure from the artesian well supplying water was sufficient to carry cooling water through the condenser.

Increased Demand for Power

The increase in size and weight of locomotives being handled in the shops and roundhouse and the generally increased demands for all kinds of repair work made it necessary to modernize the shops at Jacksonville and add to the machine tool equipment. This in turn required more power, additional boiler capacity and larger generators. The plant at present consists of four 187 hp. Stirling boilers in two batteries, one 252 hp. and one 274 hp. Erie City vertical water tube boiler set separately. All boilers are connected to a concrete stack 6 ft. 6 in. inside diameter, 175 ft. high, which gives a draft of 1¼-in., while the best obtainable draft with separate stacks was 0.3 in.

Power is now supplied by one 500 kw. turbine-driven alternator, one 120 kw. direct-current and one 120 kw. alternating current generator, each direct connected to tandem compound steam engines. Two 500 and one 1,000-gal. per minute underwriters' steam fire pumps supply water and afford fire protection, while one 925 cu. ft. and one 1,500 cu. ft. steam-driven air compressors supply the compressed air required. The 120 kw. alternating current generator is used for the night operations. The turbine is operated condensing having vacuum, dry air and circulating pumps, the water used being conserved by a concrete spray cooling pond having a capacity of 200,000 gal. located about 500 ft. distant, from whence it is pumped back into the water mains for fire and service purposes. On account of objections raised by the mechanics, a separate water line for drinking purposes supplying water not passing through condenser or reservoir has been put in. Feed water is supplied to boilers through an open type feed water heater, using a battery of regular type feed pumps with duplicate pipe lines and equipment to insure against shut downs.



Arrangement of Oil Burning Apparatus, Seaboard Air Line, Jacksonville, Fla.

Critical Situation Relieved by Oil Fuel

Due to the large increase in the cost of coal, the extremely poor quality obtainable and the difficulty in securing and keeping the labor required to fire the three shifts, great difficulty was experienced in making periodical inspections,

washing boilers and making repairs, while keeping the plant in operation. It became necessary to put two locomotives into service as auxiliary steam units, and during repair and washout times as many as three locomotives were in service. At that time there was a total connected load of approximately 1,400 hp. with a boiler plant totaling not over 1,000 hp.

With the separate stacks affording insufficient draft, poor coal and a shortage of labor it became imperative to effect some improvement in the capacity of the boilers. After a study of the situation and a discussion in regard to the probable cost of various means for increasing boiler capacity, it was decided that conversion to oil fuel in place of coal afforded the most practical means at hand. It was estimated that the initial cost of making this change was considerably less than would be required to install additional boilers and that with oil fuel the sustained capacity of the boilers could be greatly increased. However, this step was delayed and the plant continued to burn coal until December, 1919, by which time the frequent shutdowns and other operating difficulties increased until immediate relief became necessary.

Oil Burning Equipment Installed

The facilities installed for burning oil consisted of a 25,000-gal. steel storage tank and a duplicate system of oil piping leading to the pump, heating pipes being provided inside the tank and in each oil pipe line leading to the pump on account of the heavy consistency of the oil used. Each boiler was piped with steam and oil pipes with control valves located conveniently to operator's reach. Tate-Jones burners were used, modified slightly to give improved atomization of the oil and throw a better spray. The only changes made in the boilers were the building of higher bridge walls to protect the bottom drums and tubes, and slight alterations to the baffles, fire brick protections to the grates and the bricking up of all door openings.

The original plans for the oil burning system were made by the mechanical department, and the work of converting the plant from coal to oil burning was most expeditiously handled by the mechanical forces at Jacksonville.

Improvement Effected in Operating Results

Since changing this plant from coal to oil a remarkable increase in efficiency has been made as well as extensive savings in operating cost.

With the peak demand for power at present only four boilers are required to carry the load, and three have handled it successfully. At night three boilers ordinarily carry the total load and occasionally it has been cared for by two. When additional boiler power is required, a boiler can be brought from warm water to steam at working pressure and cut in on the line in 25 minutes from the time that the oil is lighted.

A marked saving has been made on account of the ease with which the oil fuel is handled and delivered to the boilers. The elimination of the ash removal, with its dirt and danger and the use of the overhead traveling crane or keeping a night crane operator on just for this purpose, has released a large force, as well as the men who were formerly required to handle coal and fire the boilers.

A statement showing the comparison of the working force required firing with coal and that required using oil is given.

Reliability and Economy

During 1919 the shut downs on account of bad coal and other difficulties amounted to 100 hours, while in the 5 months ending May 31, 1920, shut downs of only 1 hr. 45 minutes were directly traceable to oil fuel. Based on this, the shut down on account of oil would amount to only 4 hours per annum. During 1919, 15,503 tons of coal were used, costing $5.50 per ton or $85,266.50. For the five months ending May 31, 1920, the total oil consumption was 1,280,631 gallons or an average of 256,124 gallons per month. On this basis the annual oil consumption would be 3,073,488 gallons, which, at $1.25 per bbl., amounts to $92,204.64.

However, these conditions changed in July and the price of oil advanced to 11½ cents per gal. or an increase of 8½ cents over the original cost. This was subsequently reduced to 6 cents per gal. The consumption of oil was carefully investigated and by better heating and atomization and by changing the draft this was reduced to approximately 178,000 gallons per month, making the present monthly oil cost approximately $10,680.00.

Force Required for Coal Burning: No. men	Occupation	Monthly rate	Force Required for Oil Burning: No. men	Occupation	Monthly rate	Monthly savings
	First Shift 7 A. M. to 3 P. M.					
1	Chief engineer	$271.20	1	Chief engin'r	$271.20	
1	Engineer	194.40	1	Engineer	194.40	
1	Oiler	121.20	1	Oiler	121.20	
1	Water tender	121.20	1	Water tender	121.20	
5	Firemen	606.00	1	Fireman	121.20	$484.80
3	Ashmen	285.20				285.20
9	Coal passers	456.00				456.00
1	Cleaner	98.40	1	Cleaner	98.40	
1	Ashman foreman	121.20				121.20
	Second Shift 3 P. M. to 11 P. M.					
1	Engineer	194.40	1	Engineer	194.40	
1	Oiler	121.20	1	Oiler	121.20	
1	Water tender	114.00	1	Water tender	114.00	
4	Firemen	484.80	1	Fireman	121.20	363.60
3	Coal passers	285.20				285.20
1	Craneman (night)	171.20				171.20
1	Ashman	98.40				98.40
	Third Shift 11 P. M. to 7. A. M.					
1	Engineer	194.40	1	Engineer	194.40	
1	Oiler	121.20	1	Oiler	121.20	
1	Water tender	114.00	1	Water tender	114.00	
3	Firemen	363.60	1	Fireman	121.20	242.40
2	Coal passers	196.80				196.80
1	Cleaner	98.40	1	Cleaner	98.40	
	Total labor cost per month	$4,832.40		Total labor cost per month	$2,127.60	
	Total monthly savings				$2,704.80	
	Total labor annual savings				32,457.60	

The monthly fuel consumption based on the maximum demand for power is given below comparing oil and coal.

Burning coal (estimated, August, 1920, figures) 2,250 tons @ $6	$13,500.00	
Labor cost	4,832.40	
		$18,332.40
Burning oil August, 1920, figures oil 178,000 gallons @ $0.06	$10,680.00	
Labor cost	2,127.60	
Saving per month in favor of oil		12,807.60
		$5,524.80
or $66,297.60 per annum.		

Based on the 100 hours shut down in 1919 mentioned above and the estimated shut down of 4 hours for 1920, the difference in favor of oil fuel will be as follows: Present rates and costs being used).

Monthly oil cost (present) fuel and labor	$12,807.60	
Annual oil cost (present) fuel and labor	153,691.20	
Four hours' time lost per annum on 15 locos. in shop at $166.00 per day, shut downs chargeable to oil	27.64	
Four hours' time @ $75 per annum lost, account mechanics and others not producing account no power, shut downs chargeable to oil	300.00	
Total annual approximate operating costs burning oil		$154,018.84
Monthly coal cost (present demand), fuel and labor	$18,332.40	
Annual coal cost	219,988.80	
One hundred hours' time lost per annum on 15 locos. in shop @ $166 per day, shut downs chargeable to coal	691.00	
One hundred hours' time @ $75 per hour per annum lost account mechanics and others not producing, account no power. Shut downs chargeable to coal	7,500.00	
Total annual approximate operating costs burning coal		$228,179.80
Annual approximate cost burning coal		$228,179.80
Annual approximate cost burning oil		154,018.84
Approximate annual saving in fuel and labor by burning oil		$74,160.96

This saving will represent six per cent on the investment of $1,236,016.00, while the total cost of equipping this plant to burn oil did not exceed $5.000.00.

Heavy Brass Castings for Railroad Shops

Important Savings are Possible by Operating Brass Foundries in Conjunction with Railroad Shops

BY A FOUNDRY SUPERINTENDENT

How many locomotive days are lost annually because of the lack of brass castings, temporarily out of stock? How many miscellaneous break-down jobs could be repaired quickly if some medium for making a brass casting was available? How many tons of scrap brass, sold to an outside foundry, could be converted into brass castings at a nominal cost? The following suggestions and an analysis of the figures quoted show that there is economy in operating a brass foundry on either a large or small scale in conjunction with a railroad shop.

A railroad with 8,000 miles of track buys approximately 900,000 lb. of new driving box and rod brasses, hub plates and other heavy castings annually and sells approximately 725,000 lb. of scrap, this figure being an estimate based on actual facts. In order to arrive at a basis of comparison and compute the possible savings by making brass castings in railroad shop foundries instead of buying them the following data are used. The market price for lake copper, always quoted as a base, is 20 cents a pound. Scrap brass in most localities can be sold for 18 cents a pound. New castings are usually purchased from outside foundries at 28 cents a pound. An annual output of 725,000 lb. per year represents a daily output of about 2,416 lb. and a foundry capable of handling this tonnage would represent an investment of approximately $13,000 in buildings and grounds and $3,000 in equipment. In remelting and casting brass, there is a shrinkage of four per cent and the shrinkage in 725,000 lb. would, therefore, be 21,750 lb. to be replaced by purchase.

Table I—Comparison of Relative Costs

(A) Cost of buying new castings—	
Sold—	
725,000 lb. scrap brass at 18 cents	$130,500
Purchased—	
725,000 lb. new castings at 28 cents	203,000
Net cost	$72,500
(B) Cost of making new castings—	
Material—	
725,000 lb. scrap brass available	
21,750 lb. at 18 cents to offset shrinkage	$3,915
Sand, flour, parting, plumbago, etc.	5,430
Labor (including overhead) to convert into castings	9,070
Interest on investment, insurance, etc.	1,120
Total	$19,535
Net annual saving of (B) over (A)	$53,965

With a net annual saving of approximately $54,000 shown in Table I, the saving per pound is about 8 cents. The labor charge should not go over two cents a pound but if it went to five cents there would still be an important saving. In support of a charge of two cents a pound for labor it may be stated that one molder in a nine-hour day can turn out eight driving brasses weighing 225 lb. each or a total of 1,800 lb. If the molder is paid $1.00 an hour, this represents a cost of ½ cent a pound for direct labor. Adding ¾ cent a pound overhead and ⅛ cent a pound for shipping, handling, accounting, etc., there is a total of 1½ cents a pound. The writer is now connected with a brass foundry that is manufacturing driving brasses, hub plates, rod brasses, bushings and other heavy castings for locomotive and shop use and does not hesitate to say that, regardless of how small the castings may be, it is a poor molder who can not make them for at least one cent a pound.

Specialties can usually be purchased cheaper than they can be manufactured in railroad shops but heavy brass castings are not in this class of specialties since no extensive equipment is needed for making them. A small brass foundry, located at the principal shop on a division, and having a maximum capacity of 1,200 lb. a day, could be constructed at a small cost as shown in Fig. 1, and costs little to operate, one molder and helper handling the work. Oil is a more satisfactory melting medium than coke and if oil is used at the shop, it could easily be piped to the building and substituted for coke. As heavy casting work will predominate there is no necessity for a sprue cutter. The gates and sprues on the heavy work can be removed with a chipping hammer, which will require running an air line to the foundry. An industrial track in and out of the foundry would make for economy.

If a heavy tonnage is required and oil is available, an open flame furnace of the Rockwell, Monarch or Schwartz type should be used, as these types are capable of heating 500 lb.

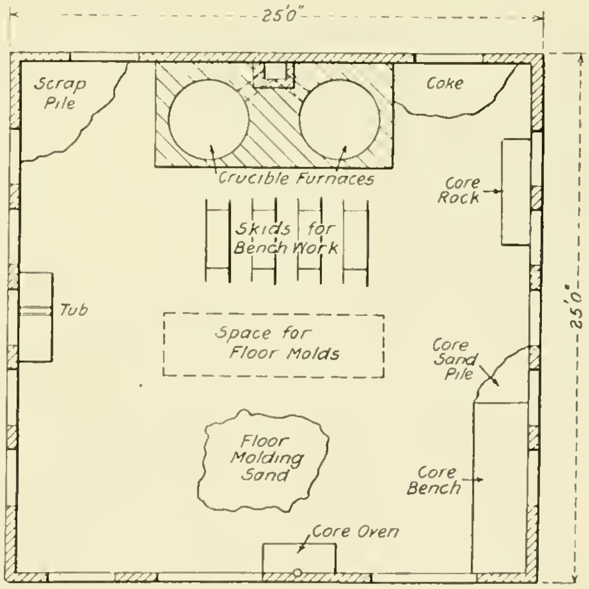


Fig. 1—Plan of Small Brass Foundry With Capacity of 1,200 Lb. a Day

every 65 to 75 min. It has been stated that a good bearing brass cannot be secured if the metal is melted in the open flame type furnace but one of the largest brass foundries in the middle west has used this type of furnace with excellent results.

Proportions of Copper, Tin and Lead

A copper, tin and lead alloy is recognized as the standard bearing bronze and while there is some argument as to the proportions, it is generally agreed that a mixture of 80 per cent copper, 10 per cent tin and 10 per cent lead is the best. The tin and lead will burn off to a slight extent, and if it is desired to maintain the standard mixture, one pound of tin and one pound of lead should be added to each 100 lb. of scrap put into the furnace. Some railroads specify the following mixture: 79 to 81 per cent copper, 9 to 11 per cent tin, 9 to 11 per cent lead, not less than .0025 phosphorus. (In order to maintain .0025 per cent phosphorus, .0075 must be added to the furnace charge on account of

shrinkage.) Phosphorus acts as a flux in the metal and not only cleanses it but changes the structure of molten brass from a creamy consistency to a watery one. One ounce of phosphorus to a ladle will do this. It also changes the color of the molten metal from a light pink to a greenish pink.

While phosphorus is decidedly hard to handle in brass casting work, it, nevertheless, is a great factor in amalgamating the metal, as a casting in which phosphorus is used has a finer grain than one from which it is omitted. The objectionable feature is that the molten phosphorus mixture has a tendency to eat into the sand and make a rough casting but experience teaches ways to overcome this difficulty.

Table II—Equipment Needed for a Foundry with a Maximum Capacity of 1,200 Lb. of Castings a Day

Core Room	
One core bench	Twenty-five core plates
One core oven	
Furnace Room	
Two crucible furnaces with pits complete	One No. 80 to 100 crucible tong
One 5 hp. motor	One No. 80 to 100 crucible shank
One centrifugal furnace	One No. 60 crucible shank
One No. 60 crucible tong	One coke fork (if coke is used)
Molding Room	
Four skids on which to place bench molds	Two No. 10 riddles
One molder's tub	Molders' tools, shovels, etc.
Two No. 2 riddles	Miscellaneous wooden and iron flasks of sizes to fit work
Two No. 6 riddles	
Cleaning Room	
One air chipping hammer	One air grinder

Directions for Melting and Pouring

If the crucible type furnace is used and the casting to be made weighs in excess of 180 lb., a 240 lb. capacity crucible is needed. The scrap metal should be put in the crucible and brought up to about 1,975 deg. F. This temperature causes a free, liquid content. About 15 minutes before lifting the crucible from the furnace, one pound of tin and one pound of lead should be added. This should be melted down and the heat brought up to 1,975 deg. again. The molten metal must be stirred thoroughly in order to get the lighter metals mixed with the heavier. Lift the crucible out of the furnace and carry it to the pour-off floor. The metal should be poured at about 1,700 deg. F. A lower temperature might result in the metal freezing before the mold is filled up and a higher temperature would cause the metal to eat into the sand, more especially if phosphorus is used.

Should a pyrometer not be available, the pour-off man must rely on his vision to judge the heat. Molten metal at 1,800 deg. F. or more will bubble and present a rough surface. As it cools off the surface of the metal becomes more even and just before reaching 1,700 deg. F., a bubble will appear about the center of the pot and break, spreading over the entire surface and changing the complexion of the metal to a more creamy mass. The metal should be poured immediately after this takes place. Pour a small stream to begin with, gradually increasing the flow until it is all the sprue hole will stand. As the sprue fills up, ease off and at the finish, pour very lightly, filling up the sprue to the top. Shrinkage occurs in the metal almost immediately and it is therefore necessary to keep the sprue well filled. Small brass castings are comparatively simple to make, but a solid, amalgamated driving box brass presents many difficulties. There must be no blow holes, and the copper, tin and lead must be thoroughly mixed with no segregation.

Molding Driving Box Brasses

Equally important with the heating and pouring of metal is the making of the mold. In the first place the proper sand is essential and Albany floor sand is recommended as one of the best. After repeated tests as to position of pattern in the mold, it is generally agreed that the crown should be placed up, which puts the bearing surface down as shown in Fig 2. Regardless of the quality of metal used there is bound to be some slag. This slag will therefore appear in the crown or top of the brass instead of on the wearing surface. Fig. 2 shows the position of the pattern, gate, sprue, etc.

It will be noted that the sprue is heavy while the runners leading from the sprue are light. It is found to be good

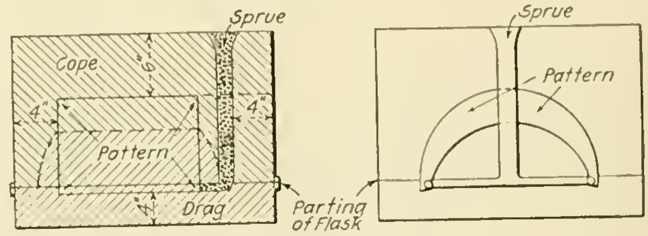


Fig. 2—Proper Method of Casting Driving Box Brass

practice to have considerable weight behind the flowing metal but to choke it down to a finer stream before entering the casting space in the mold.

About four inches of sand should be used on all sides and below the pattern and six inches above. Weights on top of mold will prevent the metal from floating the sand on top. The drag should first be rammed, then the cope. A hand floor rammer should be used, being careful not to strike the pattern with the rammer. Hard ramming adjacent to the pattern and easier away from it will secure the best results. After the cope is rammed and before the pattern is pulled, the cope should be thoroughly vented, using a vent iron about 3/16 in. thick (pointed on the end), being careful not to run the vents up to the pattern.

After opening the mold and removing the patterns, paint the mold wlth a thick layer of plumbago, using a soft camel's hair brush for this purpose. It is good practice to skin-dry the mold but not essential. Molds should not be allowed to stand over 12 or 14 hours before pouring off. The mold can be dumped in about 1 hour and 30 minutes using a wire brush immediately to remove fins and other irregularities.

There are five important things to remember about brass molding: (1) get the metal thoroughly mixed and pour off at about 1,700 deg. F.; (2) use a first-class floor sand for the mold; (3) use a large sprue; (4) pour slowly at first and then rush the metal; (5) use plumbago profusely. First-class castings can be made in a small foundry and the railroad company will save about 8 cents a pound.

DRILLING RECORDS

Production and penetration records in drilling steel and cast iron were established on October 4 at the American Foundrymen's Association convention, Columbus, Ohio, by Hercules high speed twist drills, made by the Whitman & Barnes Manufacturing Co., Akron, Ohio. The speeds and feeds used in the tests are not advisable for every-day shop use, but indicate the excessive strains that modern drills will withstand. Production records are more valuable than penetration records as showing how many holes can be drilled at one grinding.

Production Records

Material Drilled	Size of Drill	Rev. per Minute	Feed per Rev.	Penetration per Minute	Thickness of Material	Time per Hole	Holes per Grinding
Cast iron....	1 in.	665	.096 in.	63.8 in.	3½ in.	3¼ sec.	61
Cast iron....	1⅛ in.	309	.060 in.	18.5 in.	4¼ in.	13¾ sec.	303
Machine steel	2 in.	157	.045 in.	7.1 in.	3 in.	25½ sec.	28*
Chrome nickel Steel	1 in.	309	.030 in.	9.3 in.	3 in.	19⅓ sec.	72

*A total of 43 holes were made by this drill on one grinding. First 15 in cast iron 3½ in thick at 309 r. p. m. with .096 feed, then the above 28 holes in machine steel.

Penetration Records

Material Drilled	Size of Drill	Rev. per Minute	Feed per rev.	Penetration per Minute
Cast iron	⅞ in.	873	.096 in.	83.8 in.
Cast iron	1 in.	873	.096 in.	83.8 in.
Cast iron	2 in.	597	.096 in.	57.3 in.
Machine steel	1 in.	665	.060 in.	39.9 in.
Machine steel	1¼ in.	442	.060 in.	26.5 in.
Machine steel	1½ in.	442	.051 in.	22.5 in.

Locomotive Shop Organization and Methods*

A Prize Essay on the Best Method of Obtaining the Maximum Output Consistent with Good Work

BY A. F. VIVIAN

Chief Draftsman, Oudh & Rohilkhand Railway, Lucknow, India

BEFORE it is practicable to consider the method of a repair shop system or any other special factors which make themselves felt in the output of work, it is desirable to outline various general classes of repairs which locomotives may have to undergo. These may be classified as follows:—

(1) Minor; (2) light; (3) heavy.

(1) *Minor repairs* are work that lies within the scope of the running shed equipment and staff.

(2) *Light repairs* are work of the nature of re-turning of wheels, lining driving boxes, overhauling motion parts, skimming up piston and valve-rods, examination of boiler, renewal of water-space stays and attention to tubes.

(3) *Heavy repairs* is the class of work where *extensive* repairs are needed to the boiler, wheels, driving boxes, motion work cylinders and steam pipes.

Locomotives needing repairs under classes (2) and (3) only are sent into shops, which is after they have run approximately 40,000 to 80,000 miles.

Output

When these locomotives come to the shops for repairs their out-turn and the progress of the work through the shops depends mainly on the following points:—

(1) Lay-out of works and machinery employed;
(2) Labor; and
(3) Standardization of locomotives.

Layout

The lay-out of the works calls for ingenuity, which only those engaged with the preparation and assembling of locomotive parts can give to the subject. The relation of one department to another as regards proximity and transport of material must have equal consideration with the fixing of plan and machines in the shops themselves, while the timing of each department, so that all may keep in step without either delays or over-production, is very important. No doubling back in the passage of the material through the various processes and machines must be allowed. "In at one door and out at the other" is ever the motto to be kept in mind from the advent of the raw material to the steam trials of the finished locomotives. The pattern shops and wheel-turning department should be located as near the foundries and forge as can be conveniently arranged.

The steel foundry is as necessary an adjunct to a large railway works as an iron foundry—the successful introduction of the small converter having made this step a desirable one in many obvious ways.

The main boiler house and power station must be in a central part of the works for steam, power and light distribution. Wherever possible, individual punching and shearing machines should be motor-driven, and in the bay devoted to machine tools—these may be driven from a main shaft coupled to a wall engine or motor. All heavier punching and shearing machines should be equipped with their own jib cranes. Arrangements for turning out regular quantities of boiler stays by automatic screw machines should be made in the machine shop. Boiler tubes are often stored out of doors, and though the tubes may show no great amount of deterioration undoubtedly they have commenced to rust in spots, and quite likely will have to be removed from the boiler sooner than would have been necessary had they been properly cared for under cover. The life of the tube is shortened; but this is not the only loss, as there is the labor of taking the tubes out and loss of the use of the engine while removing the defective tubes, and this means time lost.

The blacksmith shop should be replete with tools and machines to meet the present-day requirements. Besides Brett steam drop stamps of 30, 20 and 5 cwt. capacity, a few 10-cwt. lifter stamps worked by hand power would be found very useful. The other machines that would be necessary are bolt and nut machines, a couple of Acme riveting and forging machines, one 3-in. Ajax, one Ryder swaging machine, two Bradley hammers, and a couple of double shearing machines.

The work of the spring maker is greatly facilitated by the use of a spring-plate preparing machine. A spring-testing machine would also be found very useful.

The machine shop should consist of complete installation of modern machine tools suitably arranged for proper sequence of work, and it is the expeditious handling of these tools that results in greatly increased output. It is very essential that there should be a well-equipped tool room fenced off from the rest of the shop, devoted to tool manufacture as well as for the making of jigs and jackets for repetition work, the grinding of lathe tools, drills and drilling cutters. All automatic and labor-saving machines should be used for repetition work required in large numbers.

In the erecting shop electric traversers should be used to convey the engines in and out of the shop, and would be in addition to the overhead cranes. A 2-ft tramway on either side of the traverser would be found useful for the conveyance of material to any bay. And as regards the equipment in general, much more attention should be given, as the locomotives of to-day have increased in weight and power and call for different methods of manufacture, and large and more powerful machines are needed to cope with the new requirements.

The stores should be located in a spot convenient to all the shops, as each has dealings with it in some way or other. A branch of the stores department should be assigned to the iron foundry, so that an accurate account may be kept of the output. Articles having thread connections should not be left exposed to the weather, as this renders them almost valueless. Nor should they be roughly handled so that the threads are broken and in many cases the entire article must be scrapped because of bad threads. Rubber hose and all kinds of rubber naturally deteriorate after it has been on hand any great length of time. This should be thoroughly understood by those handling rubber goods, so that sheet rubber and packing and hose which has been on hand longest will be used first, also that proper care may be taken of it, so it is not stored in bright sunlight or in some unusually dry place. Proper housing and storing invariably means reduced cost in handling, and hence less time, besides keeping the material in better condition for use.

The conveyance of material from the stores to the shops, or, from one shop to another, should be done by storage battery trucks, tractors and trailers. It has been estimated that the cost of operating an electric tractor is about equivalent to the daily wage of a trucker. Considering this fact, with the ability of a tractor and a few trailers to do the work

* This article, which appeared recently in the Railway Engineer, was awarded a first prize in a competition. Many of the suggestions which it contains could well be put into practice in American railroad shops.

of six to ten hand trucks, the economy is obvious. These powerful little electric storage machines are made foolproof, and with their use the handling problem is simplified.

The handling of materials.—A factor of great importance is the care of handling material. A great deal of money is lost and time wasted by breakage, leakage and marring of material in various ways, which unfit it for service, a great deal of which could be overcome if the material is properly handled and cared for. Every man having to do with the handling of material should, so far as is possible, be instructed as to the nature of the material, the use to which it is to be put, and the ways in which it may be damaged so that it loses its usefulness entirely, or, at least, injured so that only partial service may be had from it, and even that service is often of the kind that requires a great deal of extra attention. A little rough handling, in most cases entirely unintentional on the part of the man handling the material, causes expense away out of proportion to the value of the article itself, to say nothing of the delay.

Labor

System of work applying to locomotive repairs.—Experience shows that, before any system of despatching or scheduling of work through the shops can be affirmed, there must be, first, a predetermined route, and, second, a predetermined time limit.

With the above in view, the general outline of a working system is hereby made. In order to properly carry it out it is necessary to have a competent schedule man, with authority to check up the system, which is as follows:—

The locomotive is to be thoroughly inspected prior to entering the shops, and the schedule man furnished with a copy of the inspection report, from which the shopping schedule is prepared. Separate forms should then be made out by the schedule man, covering parts to be repaired in various shops, and furnished to each foreman. The first of these forms should show the locomotive number, class, date in and date out of shops, and, under the heading "class of work," various units of the locomotive, condensed into not exceeding 30 items, to be listed in consecutive order in which the parts of the locomotive are dismantled and erected. Space is provided opposite each of these items for the date each particular item is to be dismantled or repairs started, and the date the repairs are to be completed and erected. Space also should be provided opposite each of these items for parts of the locomotive that it is necessary to send to the machine, smith or boiler shops, for the dates these parts should be received in various shops, and the dates they are to be completed. Space also provided opposite each item under the heading of "Remarks," for "The cause of the delay," if any.

The second form, a "Daily schedule delay report" to be furnished by the schedule man to the officers in charge, this form to cover all locomotives in shop in which any part is behind schedule time. Opposite the individual engine numbers space shall be provided for the various units of repairs. Under the heading covering the units of repair, space is to be provided for a check mark to show just what items are behind the schedule and delaying the work, together with the cause.

Oxy-acetylene welding system.—This is a great asset, and a few remarks may not be out of place. The oxy-acetylene cutting process may be used in locomotive shops, both in constructional work and for cutting up old boilers, tanks, etc. In boiler work, manholes, fireholes and mud holes can be cut out of the solid plate, frequently at a cheaper rate than by punching, drilling and slotting. The rapidity with which the oxy-acetylene blowpipe has been taken up by engineers throughout the world is in itself the most striking testimony to its merit, and it is not too much to say that it affords one of the most practical and valuable methods yet discovered for dealing with work in the shops, be it either new or repair. As regards cost, much depends on the nature of the work and the capacity of the workman, but it may be stated generally that the system compares very favorably with the cost of most riveted or brazed work not over ½ in. in thickness.

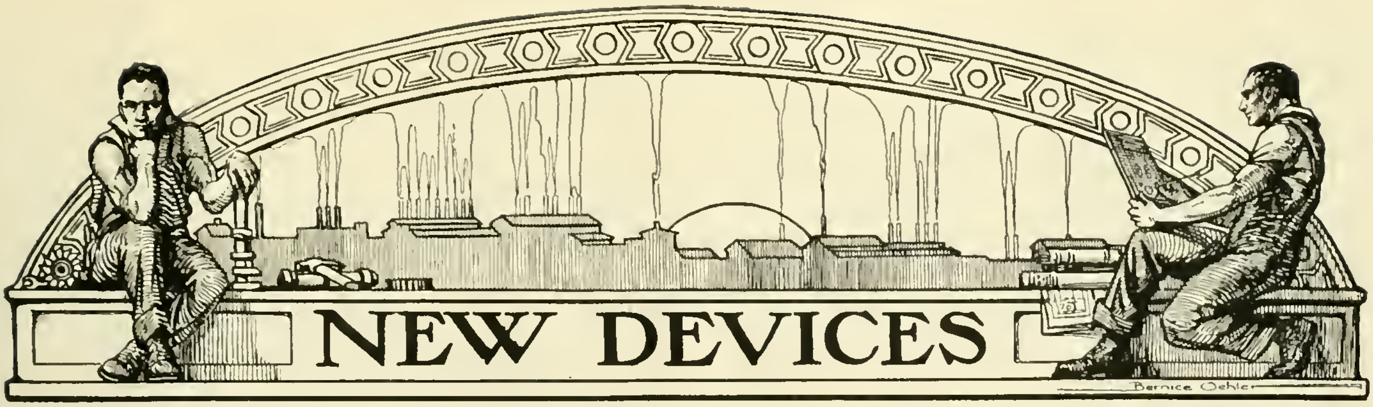
Repetition work in locomotive shops.—One of the lessons learnt from the war is that very great possibilities exist of accurately working to standard dimensions and given limits for component parts. There is undoubtedly a future for development in the design and lay-out of tools for interchangeable and repetition production, and this is a matter which concerns the locomotive as well as other machine shops. Its application will be of a more decided character than heretofore with the standard locomotive looming in the foreground. Reliable and standard limit systems, first for manufacturing, and, secondly, for tools, are necessary to suit modern methods and for all classes of works, and these must be framed from the experience gained in the use of the several existing systems, all of which are far from perfect. Since success depends upon an abundance of special tools and appliances, improved and quicker means must be devised for making them. There is, again, considerable scope for investigation in the methods of hardening high-speed and tool steels without deformation of the metal. One of the greatest manufacturing troubles now experienced is in connection with nickel steel and case-hardened parts, and for repetition work it is more than ever necessary to resort to grinding processes, so that considerable ingenuity must be given to the order in which operations are to be performed between carbonizing and quenching of the part.

Supervision.—The general conclusion is that, to ensure the efficient and economical handling of staff and material, organization is supervision. This, of course, is no new conclusion. It is self-evident. But supervision, to be effective, must be adequate in quantity. The withdrawal of the charge hand or the foreman from his duties several times a day to answer summonses from those in authority, the preparation of reports and routine work, which could be done in much less time by persons with clerical experience, are not conducive to efficient supervision.

Supervision, to be effective, must be respected. This applies to those of higher as well as lower rank. The possession of a proper designation to indicate the character of service rendered, which will command respect from those under this jurisdiction and consideration from those in other departments with whom he comes in contact, is a necessary advantage which should be given to all in charge. Competition for supervising positions should also be encouraged by making such positions as attractive as possible, and, if this is done, it will result in securing the best material available. This is highly essential if proper standards are to be maintained.

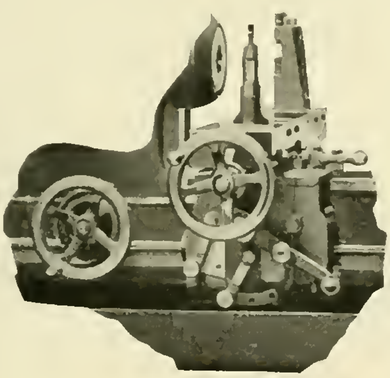
Supervision, to be effective, must also be instructive. The result aimed at is frequently missed because of a lack of understanding. To this cause may be laid many failures both of men and plans. It is necessary, therefore, that instructions should be complete, concise, understandable, and, above all, workable. It is the easiest thing in the world to give orders, but to issue voluminous orders is to ensure their being disregarded.

As regards machine shop progress in locomotive works, it may be said that, with proper supervision and the elimination of obsolete machinery, it should be possible to reduce the size of many locomotive works considerably. It is by no means unusual to find half a dozen bulky machine tools of an out-of-date description engaged in performing work which could be more easily and more economically turned out by modern tools, while at the same time reducing the amount of labor required. The principal aim is, however, that of seeking improvements by virtue of better and more widespread supervision, so that the best use can be made of every man and every machine tool and by the employment of a system which keeps a continuous and careful watch over all that is going on within the shop.

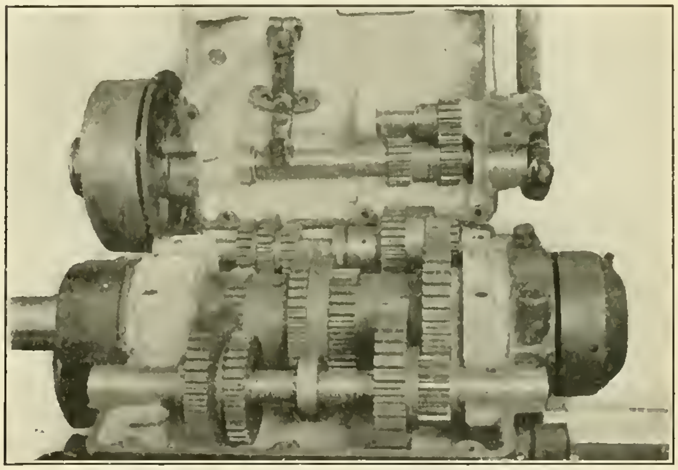


Turret Lathe of Wide Power and Speed Range

THE turret lathe, illustrated, has been developed by the Warner & Swasey Company, Cleveland, Ohio, to satisfy the demands for a machine with greater power and a range of feeds and speeds sufficient to embrace those necessary for machining the many different metals in use today; also those feeds and speeds suitable for facing, forming and cutting off operations on all diameters within the capacity of the machine. The machines have been thoroughly tested under conditions ordinarily encountered in shops and are said to have proved especially valuable in machining alloy steel gear blanks, long drilling operations in the solid, taking heavy facing and forming cuts, and other work which often occurs in railway machine shop practice.

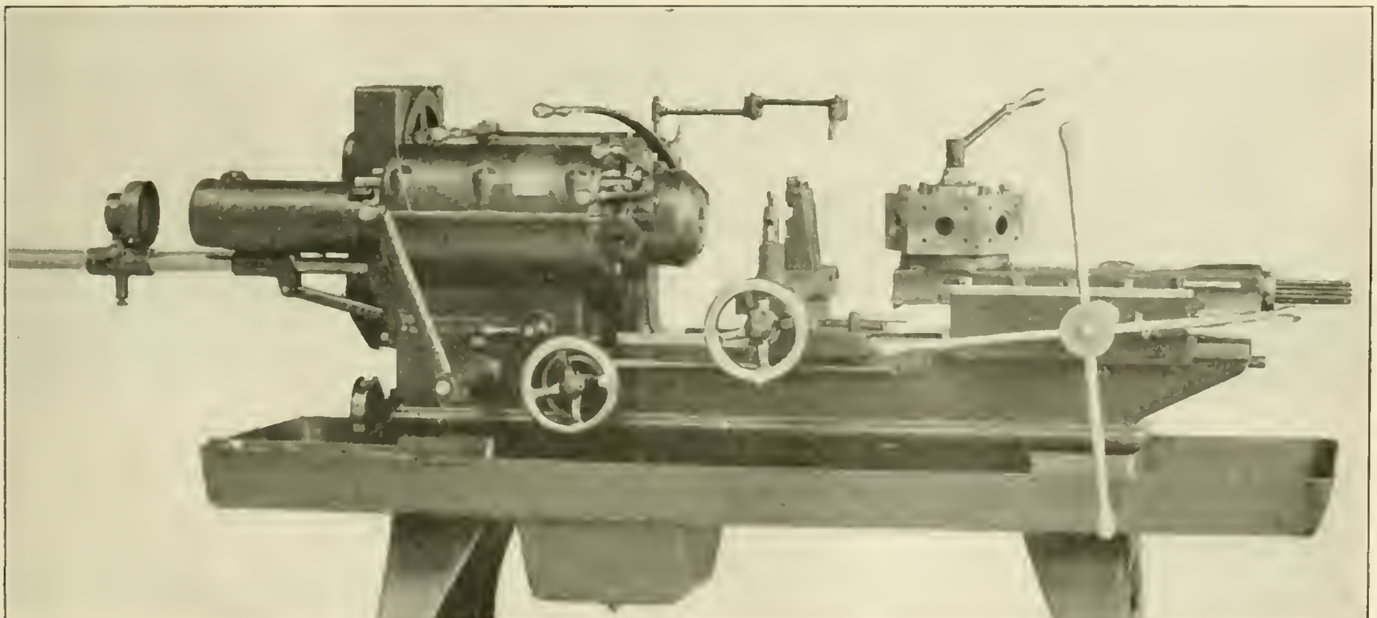


Heavy Duty Carriage



View Showing Arrangement of Gears in Head

One of the most interesting features of the new turret lathe, is the specially constructed geared head. This head consists of steel gears of coarse pitch and wide face, run-



Warner & Swasey No. 6 Geared Head Turret Lathe With Standard Cutoff

ning in oil. Two gear sets are mounted on the front shaft, while the third set and the reverse friction clutch are mounted on the back shaft. This construction is reported to give four times the power of the ordinary geared friction head of the same size machine and double the power of the double friction back geared type. With all of this increased power, less effort is required to move the controlling levers and the machine is easier to operate. The oil bath which oils the gears also lubricates the bearings.

Twelve spindle speeds and reverse are secured by the construction of the geared head which makes possible the use of the particular speed on any one job that will give the best result. It is believed that this turret lathe offers a sufficiently large number of different feeds and speeds to provide flexibility and afford the correct feed and speed for any ordinary machine operation. Another advantage of the geared head construction illustrated is its adaptability to various types of motor drive, including motor drive by means of gears, chain, or belt drive with an idler to the driving shaft.

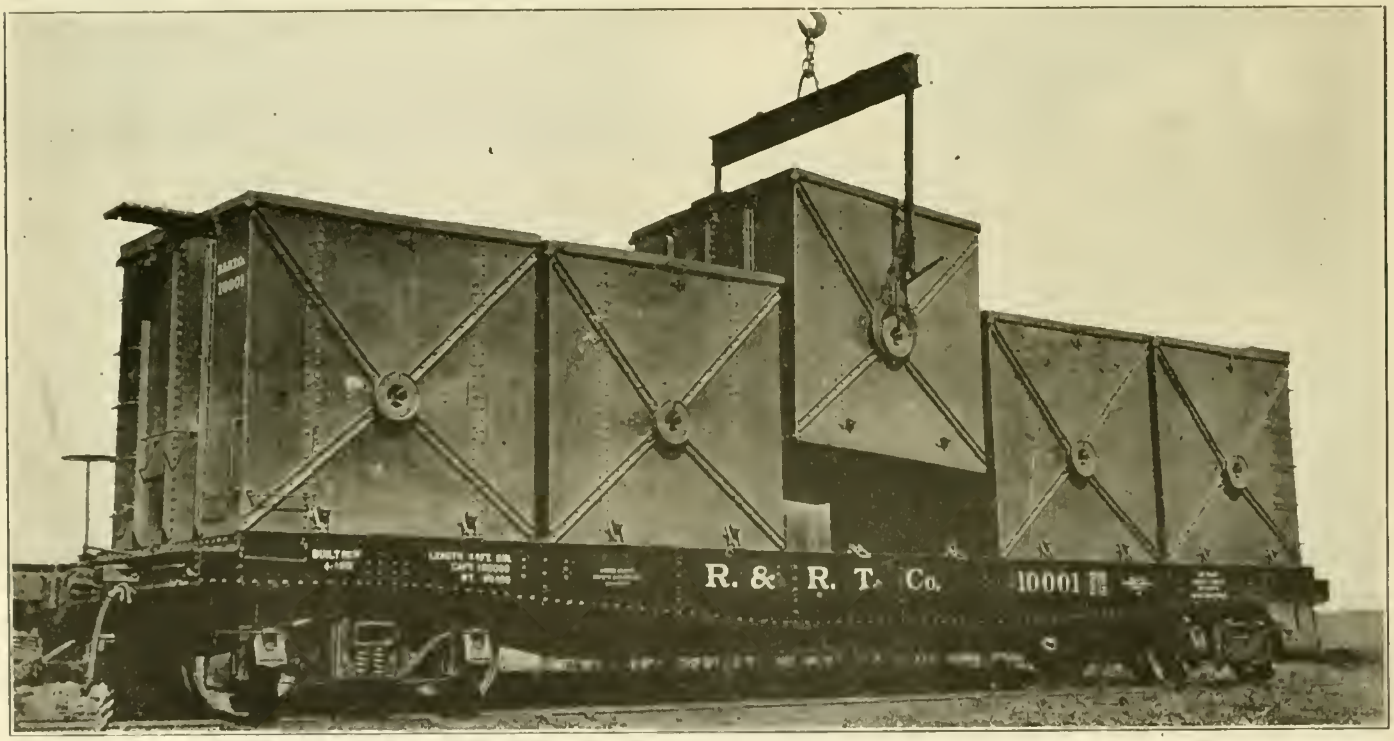
The turret lathe can be furnished with a standard type cutoff or with a new heavy duty carriage valuable for taking heavy cuts and in heavy forming operations. The range of six power cross feeds provides for all ordinary facing, forming and cutting-off feeds. The gears in the feed box controlling the carriage, as well as in the carriage apron, are of special steel designed to withstand all ordinary stress without breaking or undue wear. If desired, a square turret to carry four cutters may be substituted for the front tool post. The turrets are the same as ordinarily furnished with Warner & Swasey turret lathes and can be equipped with power feed, having four changes.

The new turret lathe is made in two sizes, the No. 4 having a capacity to take round bar stock up to 1½ in. in diameter. The swing over the bed is 16 in., over the cross slide 7 in., and the possible length that may be turned is 10 in. The No. 6 turret lathe has a capacity to take round bar stock up to 3¼ in. in diameter with a turned length of 12 in. The swing over the bed is 20⅜ in. and the swing over the cross slide is 9¼ in.

The Unit Freight Handling System

The Trinity Freight Unit—an interchangeable metal container—designed to carry freight and partially to facilitate its transfer, has been developed by the River and Rail Transportation Company, St. Louis, Missouri. These containers are made in a number of different ways for carrying various kinds of material; with side opening doors for package freight, with top doors and drop bottom for loose bulk freight, and tanks for carrying liquids. They are designed so that merchandise may be placed in a container at a manufacturing plant, or in a warehouse, the container locked and sealed, and then transported by motor truck to a railroad, or to a waterway, where the container and its contents are transferred to a flat car, or to a boat, without rehandling the material and without incurring the risk of loss so frequently resulting through theft or from the damage occurring in the more ordinary methods of handling freight.

The units are made in capacities of 2½ tons and 10 tons each and are proportioned so that five 10-ton units, or twenty 2½ ton units, or several units of both capacities, and for any of the different classes of freight can be carried on a flat car of 50 tons capacity. They are rectangular in form and are substantially constructed of steel plate rigidly reinforced with angle irons to withstand the strains due to the weight of the contents and the transferring of the unit from one vehicle to another.



Trinity Freight Units—Loose Bulk-Freight Type—on a 50-Ton Capacity Unit-System Flat Car. Method of Handling at Large Terminals

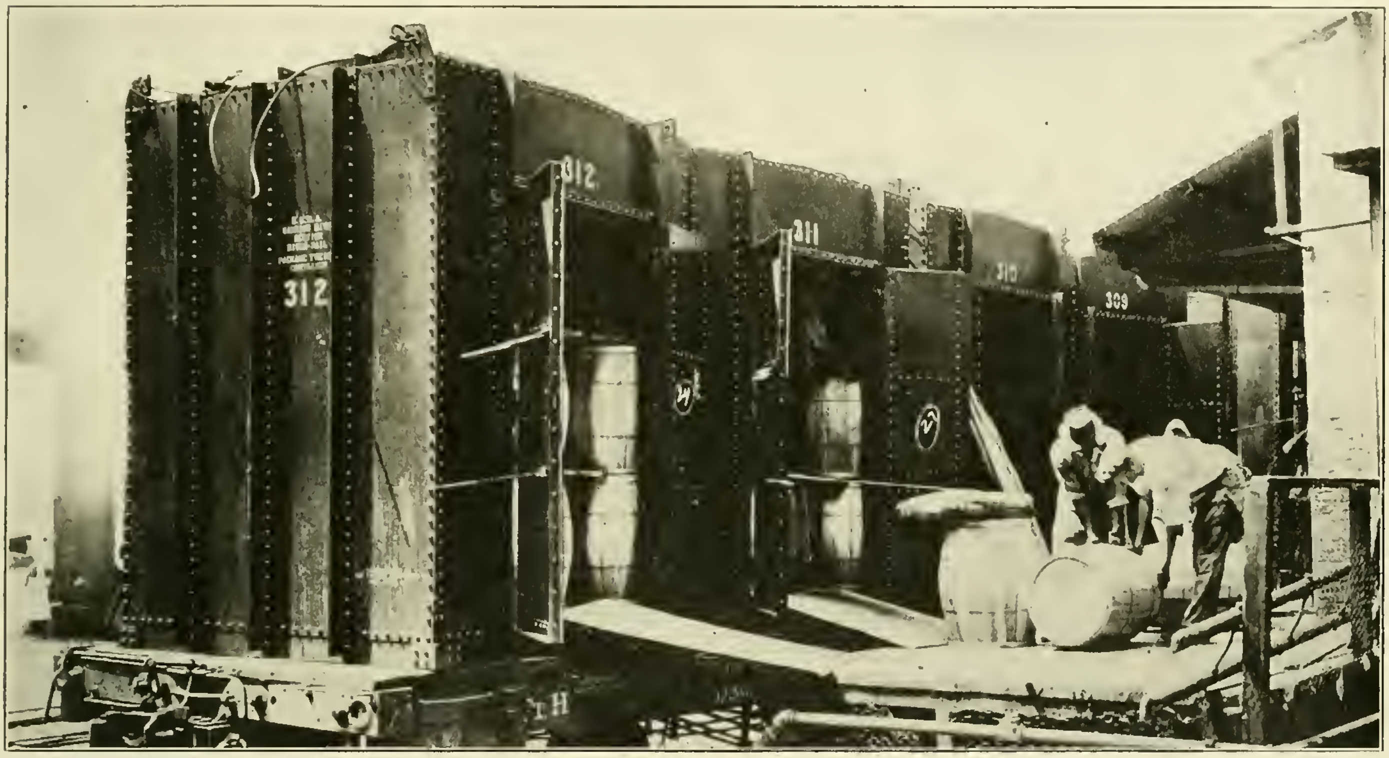
The complete freight handling equipment as developed by this company includes a specially constructed flat car. This car, however, differs from the ordinary type of flat car now in use on the railroads of the United States only in having provision made for clamping the containers to the car so that

they will withstand the shocks incident to train movement. These special cars may be constructed at practically the same cost as any other type of flat car. At a small cost, any flat car built in the usual way may be altered so that the containers can be secured to it, or in an emergency they can be secured by using side stakes.

Those containers designed for package freight are provided with side opening doors on two sides through which they are loaded or unloaded. This type of container is fitted with steel cables, attached to lugs at the top corners, by means of which it is lifted and placed on, or taken off of, the truck, car, or boat. To lift the entire unit a crane, derrick, or other lifting device is required and such equipment generally is installed in large freight houses, or yards, and at terminals. When such equipment is not available a portable crane of the motor truck type may be used. Therefore it is generally possible to handle the loaded container, but when, at small manufacturing plants, or at outlying freight houses, this can not be done, due to lack of facilities, the car on which the containers are placed may be run alongside a platform and the freight loaded in the same manner as in an ordinary box car.

The United States Railroad Administration adopted this system to facilitate water-rail shipment of war supplies. Twenty of the 10-ton package units were built and are said to have given very satisfactory service in the New Orleans district in handling package freight.

In later improved designs containers for handling loose bulk materials were equipped with ladders, handholds and running boards in the same manner as a box car. This type of container is constructed with top doors, through which the freight is loaded, and sometimes, with drop bottom doors for discharging the load. It may be loaded by hand or by means of an automatic bucket, or by other devices for handling loose materials. After loading the container the doors are closed—and locked if desired—and the entire load lifted by means of specially designed lifting links suspended from a spreader bar. These links engage in slotted trunnions on the sides of the container, keeping it in an upright position by means of a latch on the links. When the container is in the desired location the link latch can be released and the container overturned, or the drop bottom doors released—when the container is of that type—and the load discharged.



Trinity Freight Units—Package-Freight Type—on an Ordinary Flat Car. Method of Loading at a Small Station Where No Handling Equipment Is Available

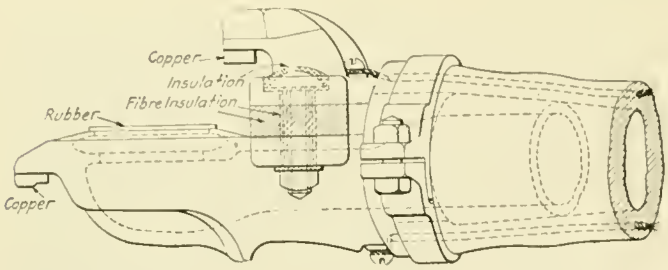
Train Signal Operated by Electricity

The Delaware & Hudson has in use on a local passenger train an electric signal, taking the place of the usual air signal, and this device has been tested for over a year, giving satisfactory service. The train circuit is normally closed, so that any failure of the battery or wires would be at once revealed. The electric apparatus, an electro-magnet valve, sounds a whistle. There is a whistle, with a miniature semaphore, not only on the engine but in each car of the train, and all signals are audible and visible throughout the train. The whistle on the locomotive is loud enough to be heard readily above any conflicting noise. With this arrangement each signal given to the engine is repeated in each car, and it is possible with a suitable code for the engineman to signal to the conductor at any time. Signals are communicated instantaneously. The train circuit is energized by four-volt gravity batteries—one in each car. The circuit controller in each car is actuated by the usual cord extending through the car, air being taken from the train line.

The train is made up of a locomotive and four cars and runs between Troy, N. Y., and Rutland, Vt., 86 miles, six round trips a week.

The connection between the cars is by means of insulated

wire in the brake hose coupling, and the man who couples the air hose by the same operation completes the electrical connection. The couplings are insulated.



Arrangement of Wiring in Hose and Coupling

The electrical connection through the hose is said to be as effective as a separate connection could be, and its cost is less. This installation was in use throughout last winter and there was no trouble experienced from ice or snow.

The experiment on this short train has illustrated the advantage and practicability of such a signal on freight trains, and except for the difficulty incident to using foreign cars, the system could be adapted to the longest train. It would be available also for telephone communication between the locomotive and the caboose. Extensive experiments, continuing through the winter, were made also, two or three years ago, on the Canadian Pacific and the Canadian National.

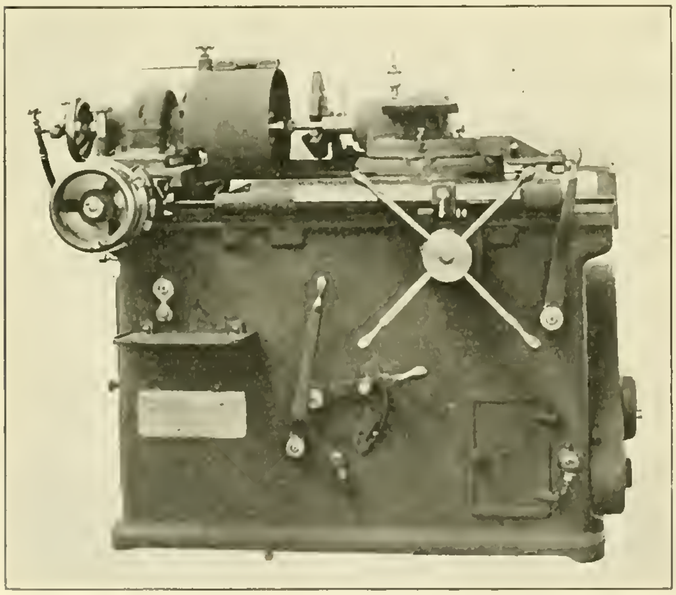
The proprietor of this system is the United States Train Signal Company, Portland, Me., and it is patented by William E. Benn and George E. Davies.

The apparatus on the Delaware & Hudson train was inspected and tested last June by the Bureau of Safety of the Interstate Commerce Commission. W. P. Borland, chief of the bureau, reporting on this test, says that "the device is designed upon sound principles, and if properly installed and maintained is capable of giving reliable train signals."

Self-Contained Internal Grinding Machine

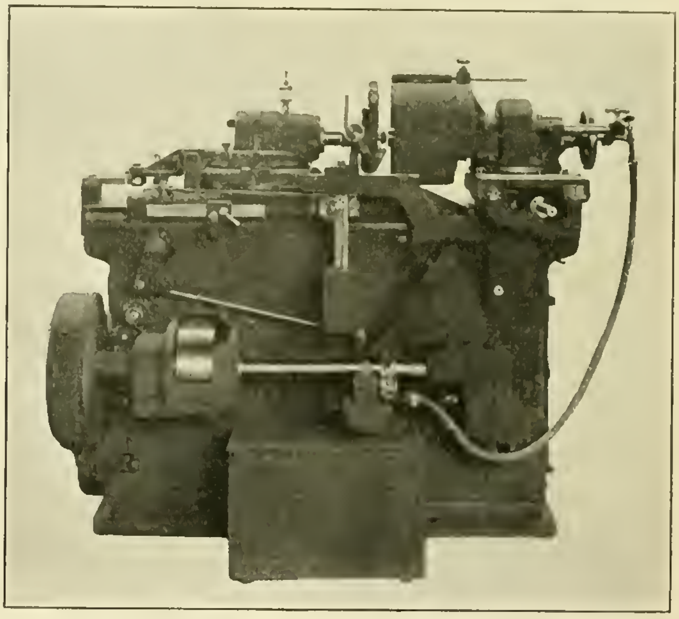
A MACHINE particularly adapted to the internal grinding of straight or tapered holes in parts which can be revolved when held in a chuck or on a face plate, has been developed by the Cincinnati Grinder Company, Cincinnati, Ohio. It can be used for grinding the holes in gears, cones, collars, cylinders, connecting rods, bushings and all work of like character which comes within its range. Face grinding can be conveniently done in correct relation to and in connection with the grinding of the holes on the external faces. This is accomplished by substituting a cup wheel for the usual straight side wheel, using the face of the former for grinding the shoulder and the periphery for grinding the hole.

Whenever it is imperative that the hole and the face of a part be finished accurately square with each other, both surfaces must be ground at the same setting. Should separate settings be made the resultant accuracy would be wholly dependent upon the closeness of the chucking which might not be within the tolerance fixed. In face grinding the position of the wheel remains unchanged, but the work-head is traversed.



No. 9 Cincinnati Internal Grinding Machine

The design of the machine consists mainly of a swiveling wheel-head carried upon a sliding table having provision for longitudinal motion, but not being movable crosswise; a work-head mounted on a cross-slide in such a manner so as to provide a sidewise movement for adjusting and feeding the work to the diameter of the wheel; an automatic reverse plate mounted on the front of the base for controlling the reversal of the table; a gear box, contained in the automatic reverse plate, for varying the speed of the table; an automatic feeding device connecting the automatic reverse plate with the cross slide feed; a gear box on the rear of the machine for controlling the rotative speed of the work; a truing diamond carrier always in position on the machine; a separate coolant tank with accompanying piping; and a complete set of water guards.



Rear View of Internal Grinder

Entirely self-contained, the machine may be driven by a single pulley from the lineshaft; by a pulley from an intermediate or jack-shaft; or, by a motor through a silent chain and sprocket. The grinding wheel is held on a spindle carried in a cylinder, tapered on the outside and mounted in a hole of corresponding taper in the wheelhead housing in which it is secured by a lock-nut. A range of wheel-heads

from maximum to minimum machine capacity is available.

Each head is a complete unit in itself, made interchangeable with all other heads. This arrangement permits of quickly substituting a head of different size when changing from the grinding of large holes to small holes or the reverse, with the additional advantage that there is no adjustment of the wheel-head required when making the change.

The forward and reverse movements of the wheel-head are obtained through the reciprocating motion of the sliding table. The direction and speed of the movement are controlled by the automatic reverse plate mounted on the front of the machine which contains a clutch of the load and fire type and a gear box supplying three changes of speed.

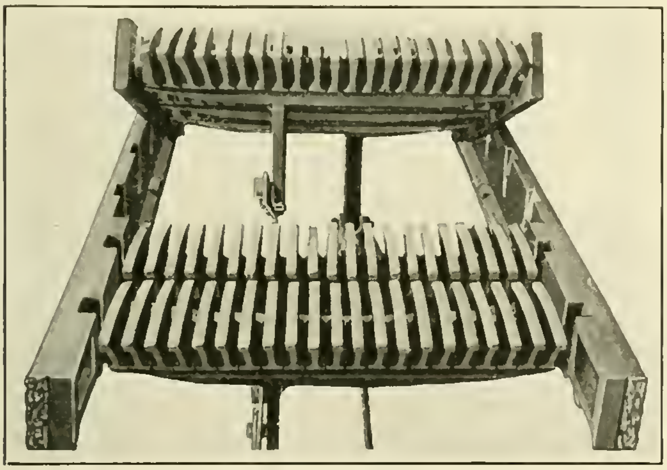
The work-head is capable of being swiveled for taper grinding to an angle of 45 deg. or less, the swiveling being accomplished by means of a hand wheel at its top, through a shaft and pinion, the latter meshing with a gear segment on the circular base of the work-head itself.

Power feed to the cross-slide, which carries the work-head, is received from the automatic reverse plate through a pawl and ratchet, the former being operated from a link set in motion by the table reverse lever. The cross-slide screw is fitted with a direct reading circular scale, for indicating the amount of stock removed, and with positive stops for use in the production of duplicate diameters.

The tank, which is proportioned to hold an adequate supply of water, carries the pump. It is separate from the machine and is set on the floor immediately next to it under the main drive shaft from which a belt runs to the driving pulley of the pump. Detachable water guards are provided.

The Hulson Shaking Dump Grate

The dump grate has always been a necessary evil in the locomotive firebox, necessary for the removal of clinkers when cleaning fires at terminals, and an evil because of the "dead" surface of the dump or drop grate, from which it is impossible to remove the accumulation of ash while the locomotive is in operation between terminals.



Hulson Locomotive Grate With the Lifting Grate Open

The effective grate area is, therefore, practically reduced by the area of the dump grate.

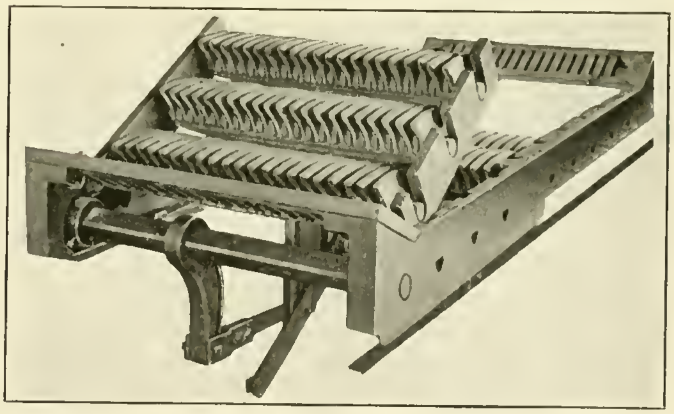
In order that the entire area of the grate may be uniformly effective, the Hulson Grate Company, Keokuk, Iowa, has designed a locomotive grate in which the drop grate is replaced by three finger bars in a frame which may be swung upward about a shaft journaled at the front end of the grate

Side View of the Grate Showing the Operating Connections

frames. Standard Hulson finger bars are used in the lifting frame and they are shaken as a part of the front section of the grate.

The construction of the device is simple and will readily be understood by reference to the illustrations. It will be seen that the side and center frames are recessed at the front ends, the length of the recess being sufficient to take in the cast steel lifting frames of rectangular cross-section with trunnion bearings for the three standard finger bars. Square holes are cored through the ends of the lifting frames, which are reinforced with hubs to provide ample strength, and the frames are mounted on a 2-in. square wrought iron staff. This staff, with the lifting frames and a cast steel lifting arm mounted on it, is placed in the stationary grate frames, one end being slipped into a circular hole cored in the side frame and the other dropped into a slot in the center frame. When assembled the slot in the center frame is closed by the front tie bar.

To permit the three finger bars in the lifting frame to be shaken with the remainder of the bars in the front section of the grate, the shaker arms of the bars in the lifting



Front End of the Grate Showing the Operating Shaft and Lifting Frames

frame and those in the remainder of the section are connected independently, the two systems being united through a second connecting rod with one connection to each system. In order that the movement of the lifting frame may not interfere with the operation of the shaker rigging, the rod connecting the three finger bars in the lifting frame is extended forward so that when the finger bars are in their normal position its end is directly under the lifting shaft. The operating connection is made at this point so that when the lifting grate is open, the finger bars retain positions parallel to each other and to the grates in the remainder of the section but change their angular position relative to the lifting frame itself. Either with the lifting frame open or closed, there is no interference with the shaking of the grates in the entire section.

The lifting grate is designed to swing through an angle of over 30 deg. and provides a vertical opening between the grate and the raised fingers of about 18 in. with a considerably larger horizontal opening under the lifting frame.

The operation of the Hulson finger grates, with their freedom from slicing action on the fire, tends to reduce the amount of clinkers to be removed at terminals and the design of the fingers is such that the grates dump much more freely when the bars are moved to the full extent of the shaking movement than is possible with the usual type of finger grates. Should heavy clinkers accumulate, however, the lifting section provides a means of clearing the grate with the least possible amount of effort. After all ash and clinker which will pass through the grates has been removed by shaking, the surface of the lifting section is cleared with a hoe, the material being drawn back towards the center of the firebox. The lifting section raised and all material still on the grates is pushed forward and dropped into the ash pan. The ledges at the bottom of the recesses in the grate frames are chamfered for practically their entire length, three short lugs being left to support the lifting frames when in the closed position. Any accumulation of clinker or ash on the ledges is thus prevented and the lifting grate will always freely drop back into place.

The lifting grate is operated from the cab, its normal position being closed, and a lock is provided to hold the operating lever in the open position when the lifting grates are raised. The possibility of the dump grate opening while the locomotive is in operation is thus entirely eliminated.

The usual location of the dump grate is at the front end of the firebox and the Hulson lifting section is designed for location at that point. Should lack of clearance under the arch in locomotives with shallow fireboxes interfere with this location, it may be placed at the rear of the firebox, in which case it swings up from the rear end, under the door.

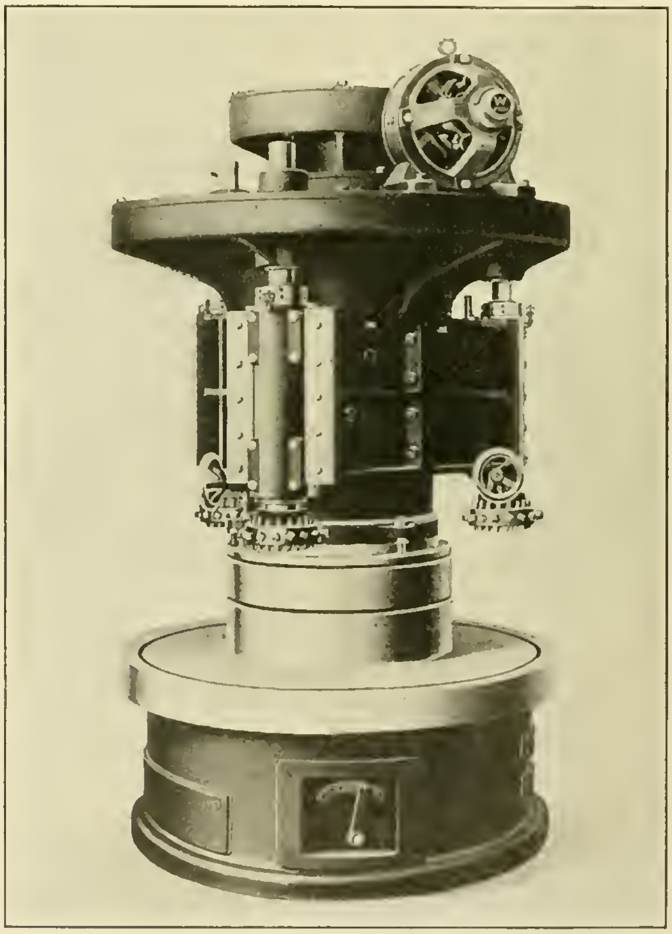
The device is simple and requires no expensive parts. The only special parts are the two cast steel lifting side frames, the square wrought iron shaft and the cast steel lifting arm. The only machine work required is the turning of the short journals. A patent has been applied for.

Continuous Vertical Type Milling Machine

The multiple spindle continuous vertical milling machine, illustrated, is now being built by the Betts Machine Company, Rochester, New York. The machine is provided with three spindles, but it can be furnished with additional spindles to meet any requirements of work where such a design is considered desirable. The machine is intended for heavy production milling on duplicate parts and in railway shops can be used to machine journal boxes, for example. The construction is simple and rigid throughout. The spindles are machined from steel forgings and are driven through long splines and spur gears. Each of the spindles carries a milling cutter and may be adjusted vertically by hand. A four spindle machine may be fitted with two roughing cutters and two finishing cutters, thereby completing the operation in one cycle. The power for driving is furnished by either a pulley or an individual electric motor.

The table has a flat bearing on the bed, and a split tapered bushing provides for taking up wear in the bearing on which the table revolves about the column. The table is driven through a large internal gear, all bearings being bronze bushed and all gears running in a bath of oil. Four rates of continuous feed are obtained through sliding steel gears. None of the gears is in mesh except those actually transmitting power, so there is no unnecessary wear. The holding fixtures are carried on the table that revolves continuously, and no time is lost in chucking the work as the pieces are changed while the fixture is passing from one cutter to the next. Depending on the nature of the work the machine has a production capacity up to three times as great as a single spindle machine.

The maximum distance from the table to the cutter is 21 in., the table diameter being 60 in. and the maximum diameter of the cutter 16 in. The table top is 25 in. above the floor, the total height and weight of the machine being 9 ft.-6 in. and 21,000 lb. respectively.



Betts Vertical Miller With Three Spindles

Chucking Job on New Automatic Lathe

The No. 5 automatic chucking lathe, illustrated, has been introduced recently to the American market by Alfred Herbert, Ltd., New York. Among its advantages may be mentioned the single pulley drive making a countershaft unnecessary. All operations are automatic, except chucking. The machine stops automatically at the conclusion of the work. Being low, the machine can be set up easily and controlled from the floor without a platform. No changing of cams is necessary for any work that can be done. Automatic speed and feed changes can be made while the tools are cutting. The head is adjustable longitudinally to allow for variations in the thickness of the work. The turret rotates at the extreme back end of the stroke. The turret is clamped automatically. The turret operating drum makes three revolutions for each forward and backward motion and is driven direct by a worm wheel without torsion. The front

and back cross slides operate independently of each other. These slides can work separately or simultaneously as required.

The headstock gear, cam drum and feed gears run in oil. All bearings are continuously lubricated, requiring little attention and assuring long life to the machine. It is possible to stop the spindle automatically at any instant, as at the end of a cut, enabling the tools to be withdrawn without leaving a spiral mark on the work. The spindle restarts automatically in time for the next tool.

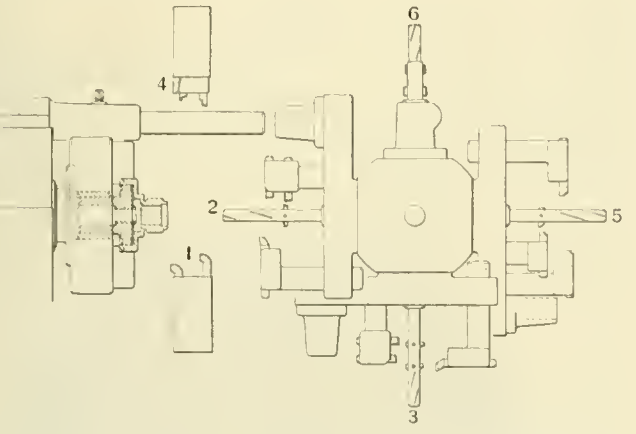


Fig. 2—Method of Tooling Automatic for Machining Clutch Gear

The more important dimensions of the machine are as follows: maximum swing over bed, 18½ in.; working stroke of turret, 13 in.; number of tool holes, 4; diameter, 2⅛ in.; maximum distance from flange of spindle to face of turret, 34 in.; minimum distance, 15 in.; diameter of turret, 11¼ in.; turret faces, 7⅞ in. by 5 in. There are seven automatic turret feeds from 16 to 144 revolutions per inch of feed. Automatic cross slide feeds are provided from 40 to 366 revolutions per inch of feed. The total speed range is from 14 to 411 r. p. m. The time for one cycle of the machine at high speed is 48 sec. The time required to rotate the turret one station is 1.1 sec. The machine consumes about seven horsepower under full load. Reference to Fig. 2 shows the method of tooling this machine for the succeeding operations on the clutch gear shown in Fig. 3.*

The gear is held on its 7¼ in. diameter in a 15 in. Coventry chuck and is located dead true by a hardened steel steady bush, which fits in the large bore. The steady bush is lined with phosphor bronze and serves to pilot the boring bars used in the various operations.

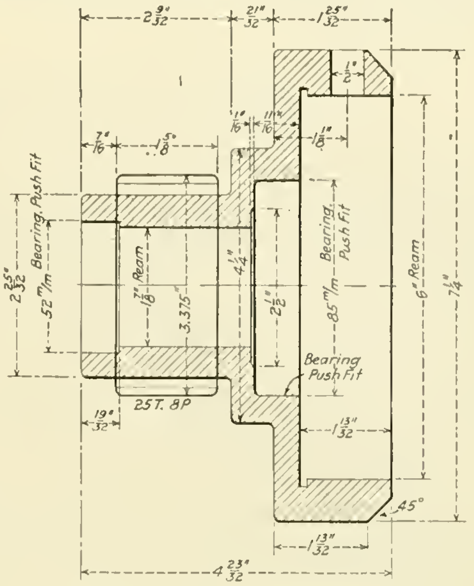


Fig. 3—Details of Clutch Gear

The large shoulder and end are first faced with tools, reference 1, Fig. 2 in the tool box on the independent cross slide. At the same time, the turret is moving forward and rough turning the 4¼ in., 3⅜ in. and 2 25/32 in. diameters and opening up the 52 millimeter ball race diameter. These operations are performed by tools, reference 2, held in a combination tool holder bolted to the turret.

The second turret face carries tools, reference 3, which take

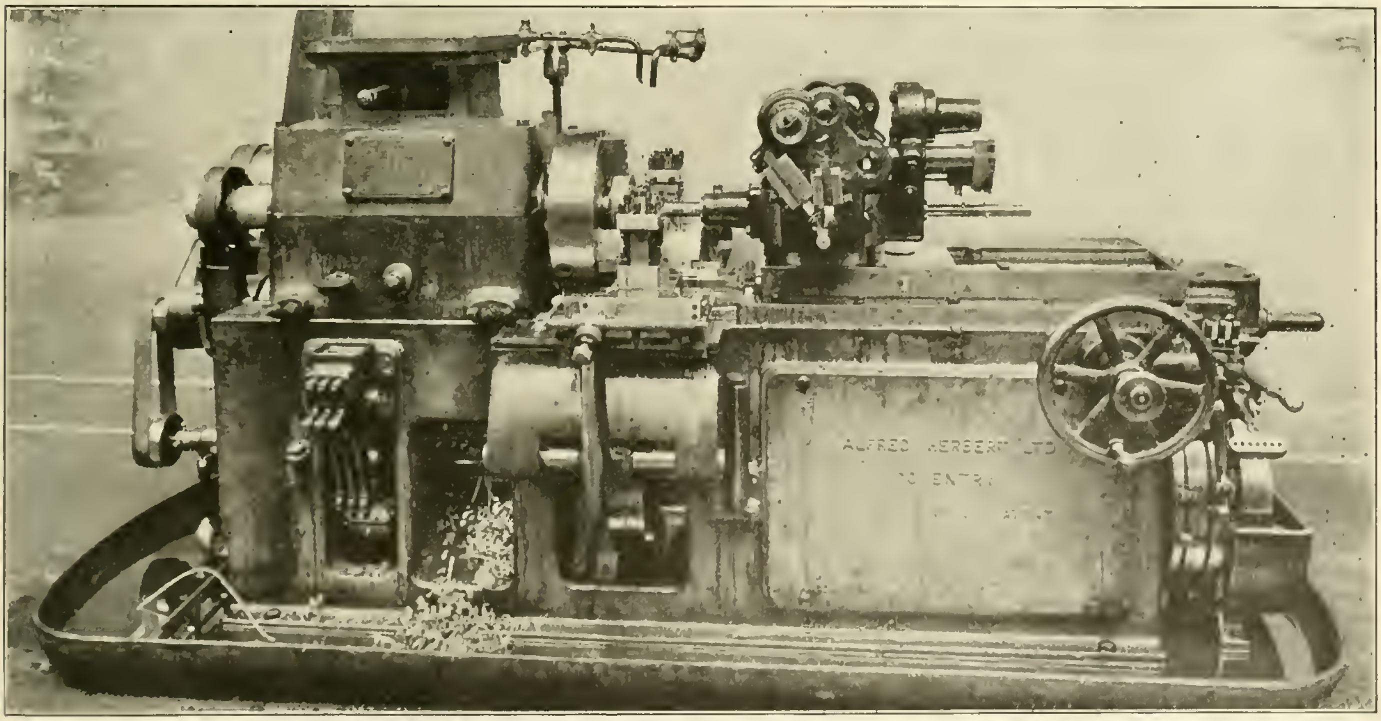


Fig. 1—Alfred Herbert No. 5 Automatic Chucking Lathe

*The first machine operations on the clutch gear, illustrated, were performed on a turret lathe as described on page 669 of the October *Railway Mechanical Engineer*.

a second cut in the bore and finish cuts on the outside diameters machined by the first set of tools. At the same time the back cross slide comes in carrying tools, reference 4, in the combination tool box, and forms the small groove, finish faces the flange and forms the radius on the end. Tool, reference 5, then comes into action and forms the radii on external diameters and chamfers the bore. The final machining operation consists of sizing the $1\frac{7}{8}$ in. and 52 millimeter bores with the floating cutters, reference 5. The limits in the bore are to .0005 in. and on the external diameters to .001 in.

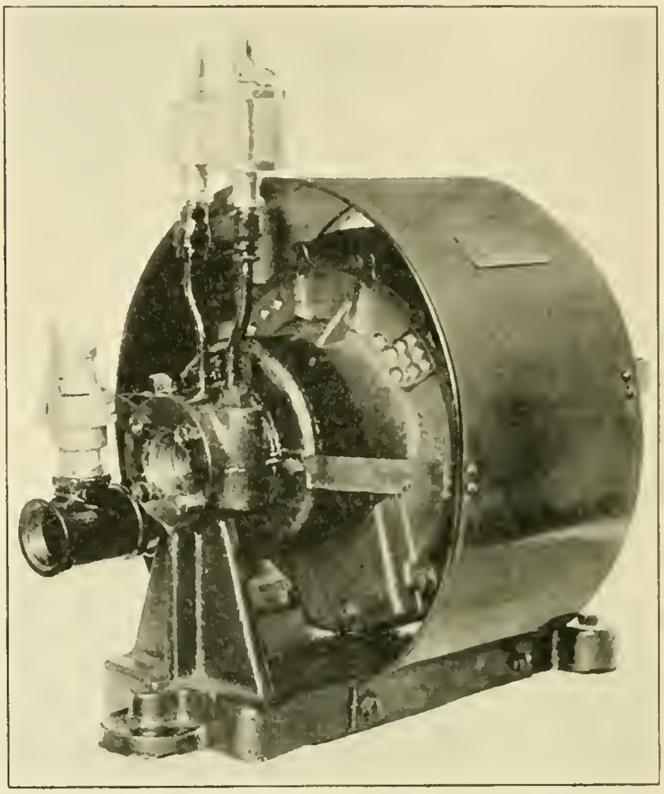
The total machining time for this operation is fifteen minutes, giving a total time of forty minutes for the complete gear.

Vacuum or Pressure Pump of New Design

AN interesting and ingenious application of motions has been introduced in the vacuum or pressure pump, illustrated, which has been placed on the market by the Crescent Sales and Engineering Company, Detroit, Mich. The motions are produced by two cylinders, one the Roto-piston, being enclosed in the other and touching it at only one point as they are mounted on different axes. The inner cylinder is revolved at the same angular speed as the outer by cranks connecting the two cylinder heads. The throw of the cranks allows the Roto-piston to maintain contact with the outer case in an apparently eccentric motion which is, nevertheless, completely balanced.

The crescent-shaped space between the cylinders is sealed at its ends by the contact of the cylinders and at another point by a vane which slides in the Roto-piston and maintains contact with the outer cylinder. The crescent-shaped working chamber remains fixed in revolution; the cylinders roll past it and the vane moves through them, displacing the space as positively as in a reciprocating pump although the motion is rotary and continuous.

Friction is small because of the few sliding contacts and the pump weighs only 150 lb. although guaranteed to create a vacuum of ½ in. of the barometer or 15 or more lb. pressure per sq. in. The pump has no valves and is self-cooling. Wearing surfaces are liberal and special features of the construction, allowing compensation for wear at these points, add greatly to its durability. In railway service, the pump can be used for spraying disinfectants, vacuum cleaning of cars, vacuum lifting of material, blowing torches, blowing heat treating furnaces and vacuum chucking.



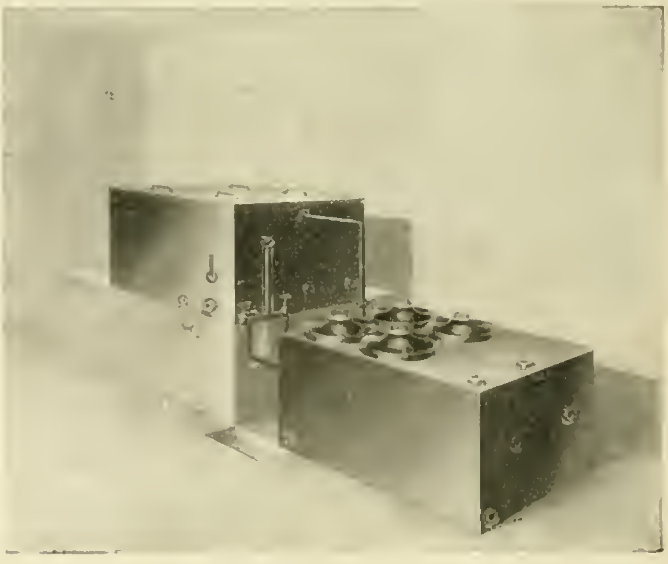
General Utility Roto-Piston Pump

Cutting Oil Filtration and Sterilization

MACHINE tool lubrication is of proven importance, otherwise there would not be a demand for such a large number of different cutting oil liquids and compounds. It was not so long ago that the ability to increase production by liquids applied to cutting tools was recognized and water was the first liquid tried. A little experience, however, proved that a mixture of soda and water was more satisfactory all around, as the tendency to rust and corrode was largely overcome. A still further advance was the use of a cutting fluid which had not only the cooling properties necessary to absorb excess heat, but lubricating qualities as well, to decrease the power consumed and speed up production.

With the production of a cutting oil which would serve the double purpose, there came the increased cost of this item and necessity of conserving it; also, the need of an equipment to filter and sterilize the liquid, thus reducing oil expense and promoting high speed operation. A good idea of the appearance and construction of a filtering and sterilizing system designed to meet this need by S. F. Bowser & Company, Inc., Filtration Engineers, Fort Wayne, Indiana, can be gained from the illustration. Tested principles of screening, precipitation, filtration and sterilization are said to be combined in a commercial and practical manner and systems essentially like the one shown have been in service for several years, giving good results.

In operation, the system can be adapted to prevailing conditions and arranged to accomplish the work required. From



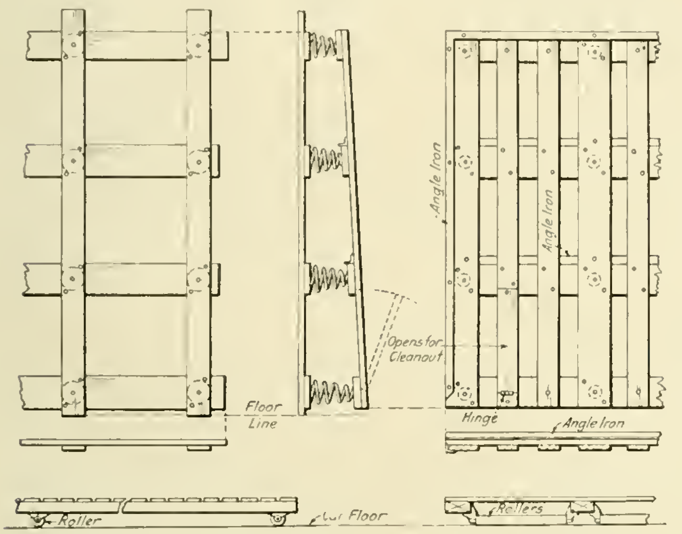
S. F. Bowser Filtering and Sterilizing System

the machines and clip separators, the oil, either by gravity or special provision, is delivered to the filter and sterilizer which automatically removes foreign matter. After going through a series of compartments, screens, filtering devices, etc., the liquid is delivered to the filter tank, which acts as a temporary storage. From this tank, the oil is returned to the machines practically the same as new oil and used again.

While the filtering process, which is automatic, is under way, the oil is also sterilized, which tends to eliminate obnoxious odors and prevent infection, thereby preserving the health of the employees. By this conservation, a better grade of oil can be used which will not rust the work or tools.

Shock Absorber for Refrigerator Cars

IN 1914, a device known as the Cutler-Monesmith shock absorber was developed by George E. Cutler, New York, and B. L. Monesmith, Cresco, Iowa, for the purpose of reducing egg breakage in shipment. The device was adapted for refrigerator cars or sheathed freight cars and could be used for shipping other products than eggs. The original arrangement consisted of a loose floor racking supported on pieces of 2-in. pipe with spring buffers at either end of the car to absorb the shock. This arrangement was somewhat crude and recent developments are shown in the illustrations.

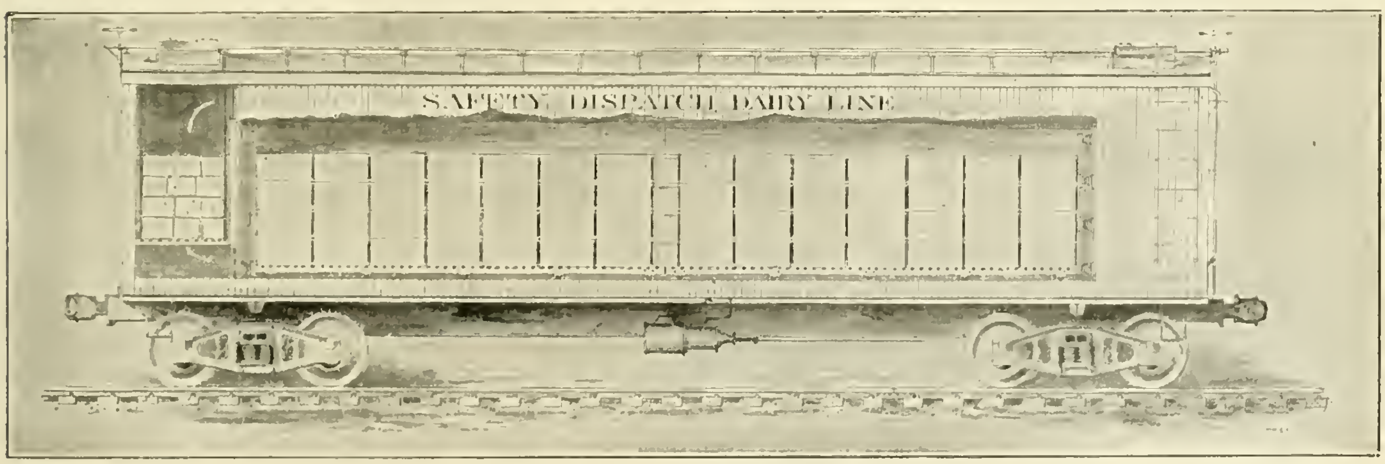


Details of Buffer Construction

The principle of the improved shock absorber is the same as that of the first device, namely, the load is held as a unit within the car on a movable floor, the shock being absorbed by spring buffers at either end. There must be no projections on the interior of the car sides to interfere with lateral movement of the load. The correctness of the principle involved was amply demonstrated by the condition of the Santa Fe refrigerator despatch car No. 8650, which arrived in New York recently loaded with eggs from central California and equipped with the Cutler-Monesmith shock absorbing device. This car was one of five test cars. As shown in the illustration, there is a space in the center of the car which was occupied by 2-in. by 4-in. bracing. As soon as the car door was opened, it was evident that the bracing had collapsed due to a severe shock, and caused some damage.

Twenty-three cases of eggs were broken, due to the collapse of this bracing, and not caused by any defect in the shock absorber. The demonstration of the efficiency of the shock absorbing device was more convincing because of the evidence of exceptionally severe and violent usage of the car. It was felt that with a proper center bracing or filler in car No. 8650, practically no breakage of eggs would have occurred in spite of the heavy shocks. Results of the test vindicated the contention of Messrs. Cutler and Monesmith that the load must be made rigid within the confines of the movable carriage and be sufficiently separated from the car sides to permit forward and backward oscillation without contact.

The floor racks are made of 1-in. by 4-in. slats and 2-in. by 4-in. stringers. It will be noticed in the line drawing that the lowest spring is greater in free length than the highest one. This gives a greater spring compression at the bottom of the buffer, where it is most needed. The length of the floor section is made such as to cause the front racks or buffers to stand in a vertical position. The width of the buffer is ¾ in. less than the interior width of the car. The buffers are ordinarily 5 ft. 8 in. above the floor of the car and 1½ in. less than the width of the car. All buffers and floor racks receive one coat of linseed oil, well rubbed in. The metal work in the device is treated with an anti-rust process.



Phantom View of Cutler-Monesmith Device Applied to Refrigerator Car

The rollers shown are made of extra heavy 1⅞ in. pipe, the journals being welded into each end of a steel plug 1¼ in. long. The journals are ¾ in. in diameter. The bearings are ordinarily made of malleable steel castings designed to support the load with a generous factor of safety. The

springs are made of spring steel wire, oil tempered and carefully coiled to correct form and dimensions. Each end of the buffer is provided with two clean-cut openings, or hand-holes, of sufficient size so that the ice bunkers may be readily cleaned. The hand-holes have a hinge at the bottom and lag screws at the top as illustrated.

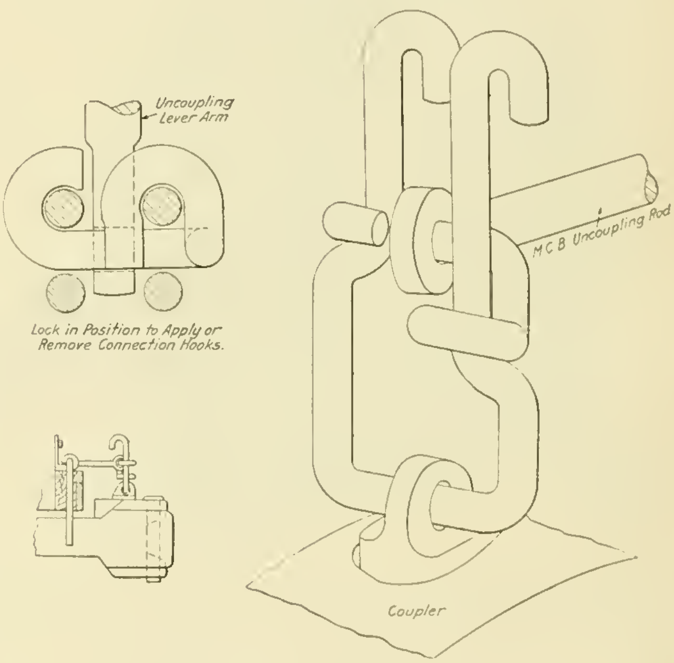
Another important advantage of this device is the fact that the load rests a few inches above the floor of the car and there can be no damage due to water. The device is adaptable to use for other merchandise and food products, being by no means limited to the transportation of eggs. In case heavier material is to be shipped, it would only be necessary to furnish springs of greater tension and possibly insert two extra springs in the bottom row. The ideal spring tension would be one sufficient to gradually return the load to its central position after a shock, and thus have it ready for the next shock.

Greater production of all kinds of material, including food products, is the compelling cry of the times, but "a penny saved is a penny earned" and the conservation of food supplies is just as important as their production. An idea of the magnitude of egg breakage and resultant loss may be obtained from a statement given out by competent authorities. During the months of May, June, July and August last, American railroads were obliged to pay one shipper alone $40,000 in damages to eggs shipped across the continent. The importance of any device tending to eliminate or reduce this breakage is therefore apparent.

Release Connection for Car Couplers

THE chain and clevis connection between the uncoupling rod and the coupler lock is troublesome to maintain in proper condition and has been responsible for a large proportion of the violations of the Safety Appliance Act falling under the classification of inoperative couplers. As a great many cars now in service are equipped with uncoupling rods to fit clevis connections, there is a large field for devices that will avoid the defects of the former standard M. C. B. design and can be applied without changing the rod.

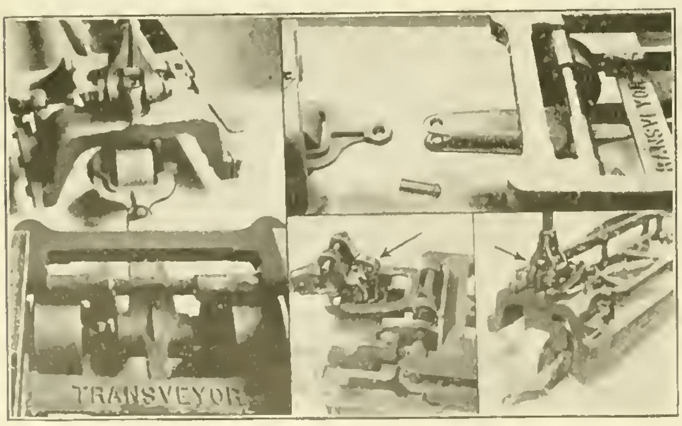
A car coupler release connection that can be applied quickly to any M. C. B. coupling lever has been invented recently and a patent on the device has been issued to Edwin Jones, passenger car foreman, Baltimore & Ohio passenger station, Cleveland, Ohio. As shown in the illustration, the connection is applied or removed simply by turning the lock fully over, when the center arm of the uncoupling lever is raised up to the connection hooks. There is no prying open or closing up of open eyes, hooks, or any other parts and the device can be applied or removed as many times as desired without weakening or destroying it. The E. D. J. O. coupler release connection, as it is called, is stated to be reliable, durable and efficient in action. Its simplicity and ease of application will be appreciated by car repairmen who have been used to the older types of connection.



Easily Applied Coupler Release Connection

Trailer Attachment Applied to Transveyor

THE attachment illustrated enables the Type G transveyor manufactured by the Cowan Truck Company, Holyoke, Mass., to be used as a trailer behind electric storage battery trucks, either singly or as a train. The attachment fits onto the front wheel and hitches to the draw bar on the rear axle of the transveyor ahead of it, or the draw bar of the electric truck. No change in the construction of the transveyor is necessary except a longer axle for the front wheel fork. The draw bar is applied to the rear axle of any transveyor without taking off the wheels, as it merely slips over the rear axle. Both the attachment and the draw bar are steel castings and will stand up under any ordinary conditions.



Cowan Transveyor Trailer Attachment and Safety Latch

In this arrangement the shortest possible connection is provided for, so that the train will be no longer than is absolutely necessary. The truck wheels follow in the same track and the turning radius is so short that a train of ten trucks has been turned in a circle on a twenty foot roadway. Plenty of up and down play is allowed so that there will be no binding as the machines go over the door sills or the top of steep inclines.

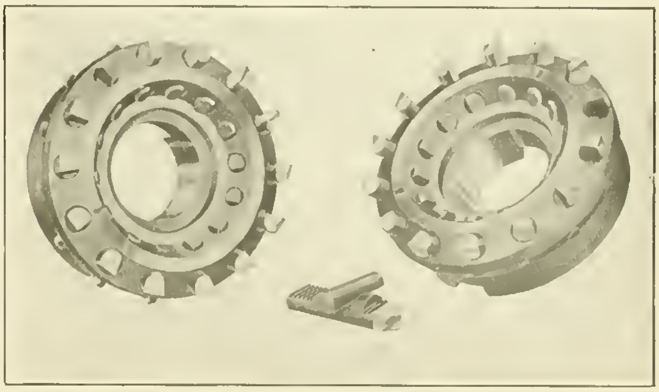
A safety handle latch has been devised for the transveyor as indicated in the illustration by arrows. This latch is made of tempered spring steel attached to the top of the king pin of the front wheel fork. It has two leaves, stiff

enough to prevent the handle from falling down. As the handle is thrown back into a vertical position, it slips over the spring, and no amount of jarring will cause the handle to fall forward. The latch, however, does not interfere with the free movement of the handle, when it is necessary to bring it down to manipulate the transveyor.

Inserted Tooth Face Milling Cutter

A NEW inserted tooth face milling cutter known as the type A cutter has been developed recently by the Lovejoy Tool Company, Inc., Springfield, Vt. The cutter is of the inserted tooth type, being recommended for all face milling operations where the depth of cut does not exceed 9/16 in. The cutter bodies are made of a tough hardened steel, designed to withstand the most severe usage. The teeth are positively locked by means of taper pins, as illustrated. This arrangement is stated to prevent any possibility of slipping or loosening under heavy or intermittent cuts. The teeth are made to gage and are interchangeable with a liberal amount of stock provided for wear.

The ease with which the teeth are adjusted forward to compensate for wear, or replaced with new ones when necessary, is an obvious advantage. It is stated that this type of body is well adapted for holding stellite and can be furnished with stellite teeth when desired. The time consumed in grinding a cutter of this type is reduced to a minimum. The new type A cutters are made in five sizes from 6½ in. diameter to 10 in.



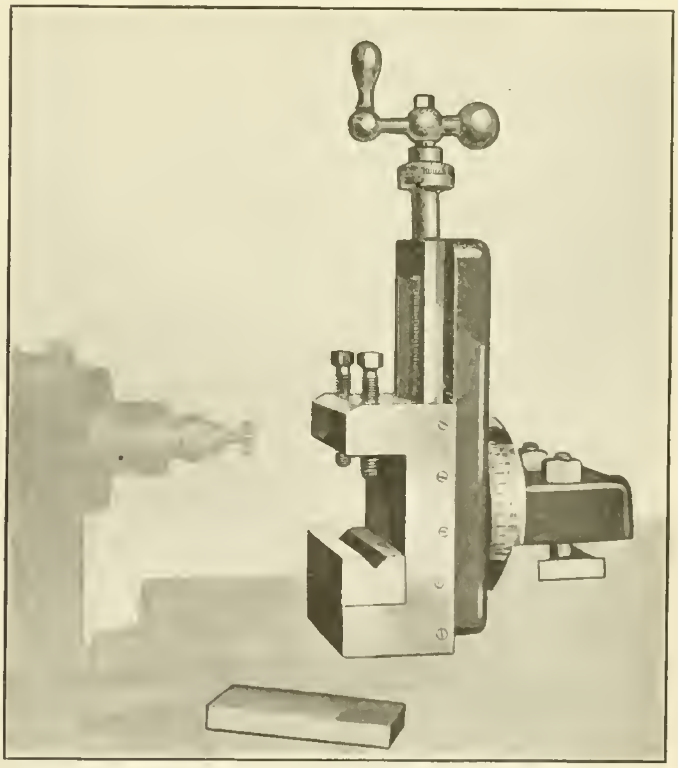
Lovejoy Inserted Tooth Face Milling Cutter

Milling Attachment for Use on Lathes

A COMPARATIVELY simple milling attachment which can be applied to engine lathes has been placed on the market by the Hinckley Machine Works, Hinckley, Ill. This attachment is adaptable to a great variety of light milling work, such as milling keyseats for both plain and Woodruff keys, squaring the ends of shafts, sawing, splining shafts, splitting bushings, drilling, boring, and numerous other jobs.

The attachment is shown in the illustration and may be applied to lathes of any make and size from 12-in. to 24-in. swing. The device swings with the compound rest to bring shafts in the right position to cut keyseats. The steel V-block lines up the shaft, which is held firmly in place by two set screws. In order to prevent marking the shaft, the block shown in the lower part of the illustration is usually placed between the shaft and the screws. A Woodruff keyseater cutter is held in the lathe spindle as shown and mills the key way.

The low center of oscillation makes the device rigid, a feature which is also secured by the use of two substantial bolts holding the attachment firmly to the cross-slide saddle. The vertical hand feed of the attachment is seven inches up and down, the cross and length feeds being the feeds of the lathe. Vertical feed is provided by means of a hand-operated ball crank and is graduated to thousandths of an inch. It is graduated to swivel in a vertical plane to 180 deg. This device can be provided ready for application to any engine lathe by submitting the dimensions of the toolpost saddle with the order.



Attachment Set Up Ready to Cut Keyseats

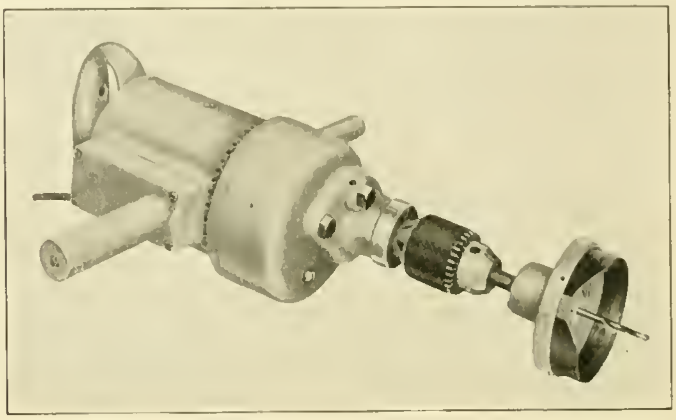
A New Duff Automatic Lowering Jack

THE Duff Manufacturing Company, Pittsburgh, Pa., has recently added to its line of automatic lowering jacks a new jack (No. 339) designed especially for removing and replacing couplers and for bridge work. A capacity of 15 tons and a lift of 11½ in. are provided. The jack has the simplified reversing mechanism of the Duff jack (No. 229) previously described in detail on page 531 of the September, 1918, *Railway Mechanical Engineer*. A fine-tooth rack and the reduction of friction makes the jack operation easy, and long life is ensured by strengthening

the jack at all points where experience has shown it to be desirable. The jack is single acting, raising only on the down stroke of the operating handle. Another advantage from the storekeepers' point of view is the fact that all parts of the new jack except the rack and base are interchangeable with the corresponding parts of previous car and journal jacks, Nos. 219, 249 and 248. This will eliminate the necessity of carrying so many different parts in stock.

Rotary Hack Saw Cuts Round Holes

The Misener rotary hack saw has been developed recently and proved a satisfactory tool for cutting round holes in metal, wood and other kinds of material. As shown in the illustration, the principle of the device is simple, since it consists of a holder, driven either by a motor or by a common bit brace, arranged to hold a hack saw blade bent in the form of a circle. Concentric grooves in the holder provide means of obtaining holes of different sizes and a small drill at the center serves to hold the tool on center. With a set of the hack saw blades furnished with this tool, it is possible to cut holes from 1 in. to 3½ in. in diameter. This rotary hack saw is light and portable and should save its cost many times over in the reduction of time previously required to drill, file and ream round holes. The device is of special value to electricians and can doubtless be used to very good effect by tinsmiths in locomotive shops who have to cut many holes through jacket iron for pipes, etc. Carpenters in the cab shop will also find many excellent opportunities to use this ingenious device. John Conolly, Rochester, N. Y., is exclusive sales agent for the Misener rotary hack saw and is prepared to make deliveries at an early date.



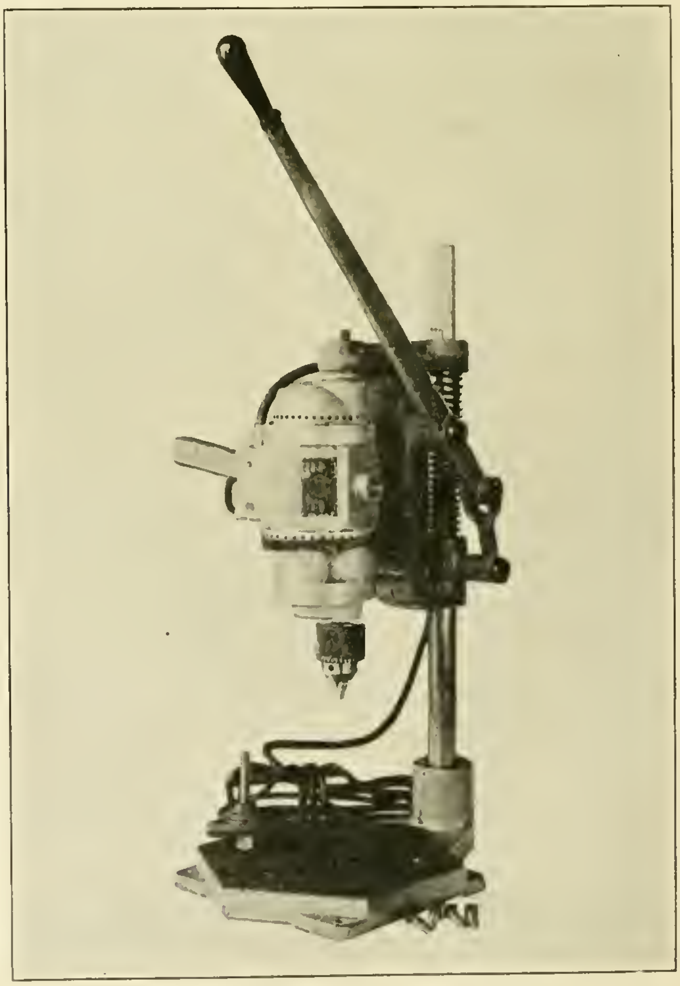
Misner Rotary Hack Saw

Convenient Type of Bench Drilling Stand

The bench drilling stand, illustrated, has been put on the market by the Black & Decker Manufacturing Company, Baltimore, Md., and is designed to take the ⅜ in., ½ in., 9/16 in., ⅝ in., and ⅞ in. portable electric drills made by that company. The bracket carrying the drill can be raised or lowered on the vertical column and is secured in any desired position by means of a split collar and clamping screw. The drill may be swung clear of the base, making it possible to use this stand for such work as drilling holes in the ends of shafts, and other work too high to be drilled on the bench.

Both vertical and horizontal adjustment are secured by means of the clamping screw. An extra long feed lever gives a feed ratio of six to one and 100 lb. pressure applied to the handle will feed the drill under 600 lb. pressure. This facilitates fast work with little effort. In the base of the stand, there are six tapped holes to accommodate ½-in. studs, used to clamp the work in place. One stud with a nut and clamp is supplied with each stand. The stand is exceptionally rigid in construction, the vertical column being a solid steel shaft 1-7/16 in. in diameter. The base is provided with four holes for fastening the stand to the bench by means of ⅜-in lag screws.

The distance from the bottom of the base to the top of the vertical column is 30 in., the vertical adjustment of drill being 12 in. The distance from the center of the drill bit to the circumference of the vertical column is 7 in. The vertical travel of drill when operated by the feed lever is 4 in. The net weight is 70 lb. The stand is shipped complete with an adapter block. The sizes and types for which adapter blocks are suitable are stamped on the blocks and only Black & Decker portable electric drills of corresponding sizes and types can be used. Perhaps the main advantage of the drilling stand, not previously mentioned, is due to the fact that radial drills and large drill presses are usually overcrowded with work and by doing many small drilling jobs at the bench, large drills are relieved of that much work.

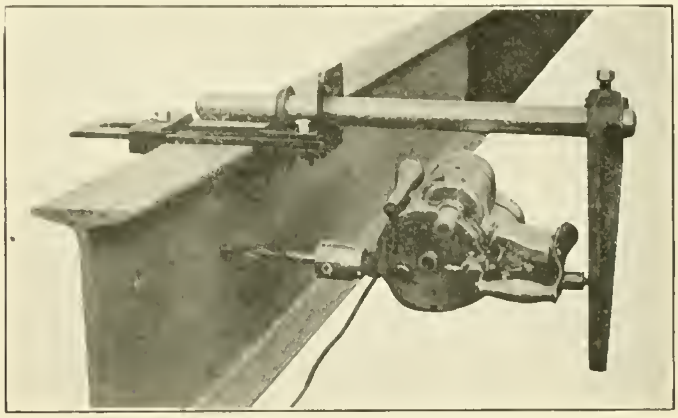


Black & Decker Bench Drilling Stand

Adaptable Drill Clamp and Support

An efficient device known as the Canton drill clamp and support has been placed on the market recently by the Poyser-Bucher Company, Canton, Ohio. This tool is intended for use on bridge and construction work where many holes have to be drilled in I-beams. Formerly such work was done with the drill held by a goose-neck, or old man, which is a more or less inefficient and expensive method because the length of time required to adjust the old style goose-neck was considerable. Also a separate adjustment had to be made for each hole.

The operation of the drill clamp and support illustrated is readily understood. By loosening up the nut and casting at the left, the support can be slipped along and a hole drilled at any point in the web desired. Should it be desired to drill holes in the top of the I-beam, the long shaft is removed and put through the support in a position at right angles to its present position. The U-bolt is then tightened around the shaft and holds it at the desired height, no further adjustment being necessary for drilling as many holes as may be desired in the top of the I-beam. The total saving in time when drilling several hundred holes is surprisingly large.



Canton Drill Clamp and Support

Recent Improvements in Cincinnati Planers

Several recent improvements in the planers manufactured by the Cincinnati Planer Company, Cincinnati, Ohio, are worthy of special attention because they mark the more extended use of the box section in planer construction. The box arch, illustrated in the upper part of Fig. 1, was designed primarily to add strength and stiffness to the housings and the upper part of the planer. This box arch is cast in a strictly box form, as shown. The top of the housings of the planer have been widened to accommodate the arch and ample provision is made for securely bolting the arch in place at all four corners.

Fig. 1—Views Showing Box Section Construction of Planer Arch and Cross Rail

The box form of construction has also been extended to the cross rail. Instead of the more familiar type of curved back, the cross rail is now constructed, as shown in Fig. 1, with a deep heavy box section which is well ribbed. It is stated that this construction adds rigidity and firmness to the machine and makes it possible to take considerably heavier cuts.

An automatic stop for the rail elevating and lowering device is clearly shown in Fig. 2, and provides a valuable safety feature which combines simplicity and convenience. In operation, the elevating device is released by the movement of a vertical stop rod, shown at the left side of the housing. This stop rod is provided with two stop collars adjusted at the limits of safe vertical travel of the cross rail. A third collar can be adjusted to stop the downward movement of the rail at any position within its range of travel. A new style saddle is shown with provision made for clamping the upper part of the swivel securely against the face of the saddle by means of a clamp. This arrangement is designed to prevent the possibility of breakage to the clapper box. Rapid power traverse for moving the rail head into position quickly and easily is another advantage claimed for this planer.

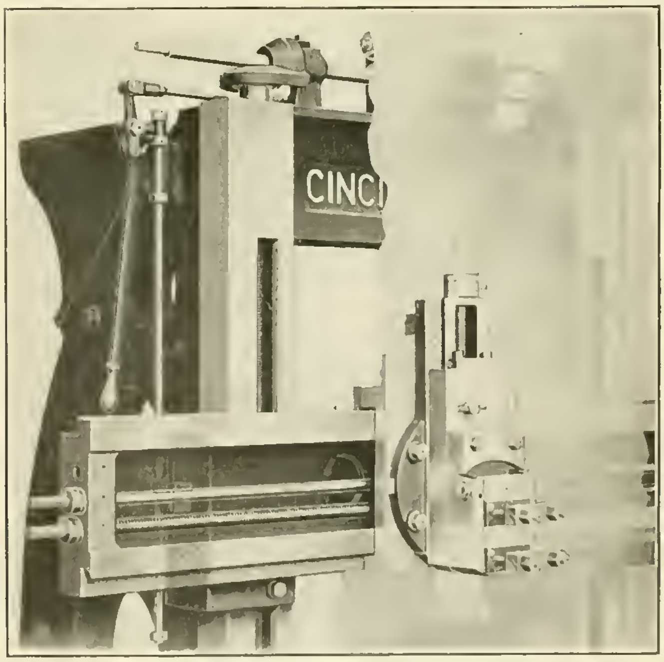


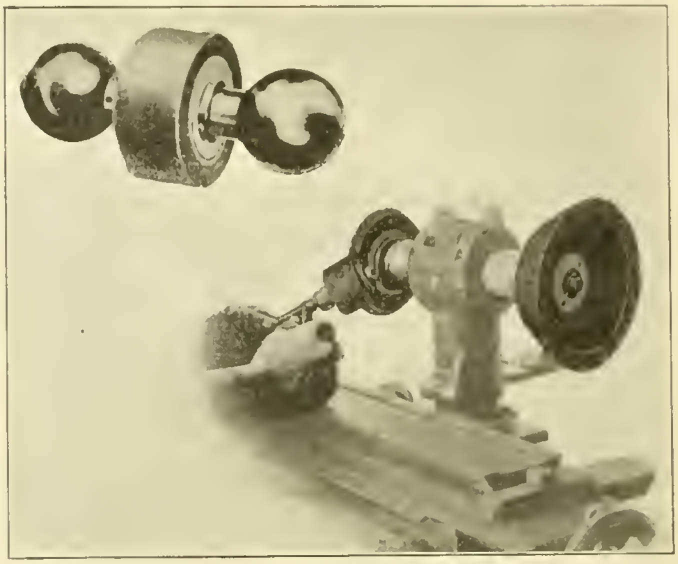
Fig. 2—Automatic Safety Stop for Elevating and Lowering Device

Grinding Wheel Dresser for Fine Wheels

It is essential that grinding wheels be kept in the best possible cutting condition because tools cannot be properly ground with wheels that are either out of round or clogged. This is especially true in tool room work where milling cutters, reamers and all sorts of cutting tools must be accurately ground.

With these facts in view the Oliver Machinery Company, Grand Rapids, Mich., has developed the Metcalf grinding wheel dresser, which is recommended and designed primarily for fine wheels 1 in. or less in thickness. This device makes it possible to turn a bevel or V-edge, or true up a square edge quickly and effectively. It prevents chipping or breaking away of the grinding wheel. On large coarse snagging wheels the Metcalf dresser is intended to supplement the work of a diamond dresser and assure a smooth grinding surface. It is equally adapted for surface and cylindrical grinding wheels and can be used in places where the space is limited.

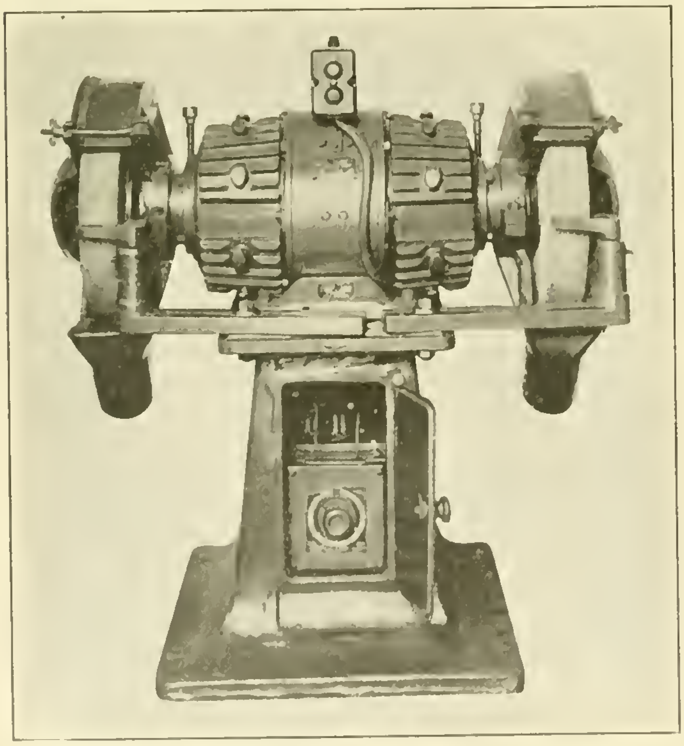
Three styles of grinding wheel dresser are provided for ordinary shop use. Type A is recommended for turning square, round, bevel or V-edges on wheels 1 in. or less in thickness. This is the most commonly used type and is very convenient for tool room use. It is shown in the illustration with the two ball handles. Type B, not illustrated, is provided with a shank which may be fastened in the tool post. Type C is designed for working in tight places, as, for example, grinding the bevel on the small wheel shown. It will dress the sides on straight or dished wheels and dresses special shapes internally.



Two Types of Oliver Grinding Wheel Dresser

Electrically Driven Tool Grinding Machine

The self-contained electrically driven grinder illustrated is particularly rugged in construction and therefore adapted to the more or less severe usage accorded machine tools in railway shops. Vibration is reduced to a minimum by providing the large base shown, with a column of generous proportions.



United States Electrical Tool Grinder

Power to drive the grinder is furnished by a 5-hp. direct current motor enclosed within the casing. Ample provision is made for the inspection of the motor, which is protected from possible injury due to falling articles by the heavy iron casing. The motor was designed especially for grinder service, being a variable speed motor with speeds ranging from 1,100 to 1,600 r.p.m.

Arrangements for increasing the speed as the grinding wheels wear down are made by means of electrical equipment shown in the pedestal of the grinder. The machine is started and stopped by means of two push buttons and is furnished with S. K. F. ball-bearings throughout. Grinding wheels 18 in. in diameter with 3 in. faces are to be used with this machine.

Wheel guards of the hinge door type, amply strong to guard against accident, are provided for the grinder as shown; also exhaust connection for carrying away the particles of dust and metal. Adjustable rests are provided for the support of tools while being ground. The grinder is manufactured by the United States Electrical Tool Company, Cincinnati, Ohio.

Rules for Handling Die-blocks.—The following rules for the handling of die-blocks are given by the Pennsylvania Forge Company, Bridesburg, Philadelphia, Pa., in a recent publication entitled "Die-blocks":

1. Never harden a block unless the impression has been carefully polished. Rough impressions are the cause of many failures.
2. Never charge cold blocks into a hot furnace.
3. Never rush heating operations. Take plenty of time and save trouble.
4. Never quench a block that shows uneven heating. If properly "soaked," the color and temperature will be the same throughout.
5. Never allow a block to become dead cold in the bath.
6. Never postpone the drawing of a die-block. Draw it immediately after hardening.
7. Drop-forging dies should never be stored in a cold, drafty place after hardening.

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London: 34 Victoria Street, Westminster, S. W. 1.
Cable Address: Urasigmec, London

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WE GUARANTEE, that of this issue 10,950 copies were printed; that of these 10,950, 9,573 were mailed to regular paid subscribers, 13 were provided for counter and news company sales, 259 were mailed to advertisers, 32 were mailed to employees and correspondents, and 1,073 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 127,050, an average of 11,550 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The Railway Business Association will move its office on November 1 from New York to Philadelphia, Pa. The new office of the association will be in the Liberty building at Broad and Chestnut streets.

Tasmania produces most of the molybdenite which is used in the manufacture of steel to give it a hardness and toughness that fits it for use as propeller shafts, long range guns and boilers that carry unusual pressure.

Twenty per cent reduction in the forces of the shops of the Norfolk & Western is to be made at once, according to a notice posted at Roanoke, Va. The reduction, according to the notice, will begin with laborers and helpers.

New York Central engine No. 999, which established the world's record in May, 1893, when it drew the Empire State Express at the rate of 112.5 miles an hour covering a mile in 32 sec., has now been placed on a side track at Depew, N. Y., where it will be dismantled and scrapped. Charles Hogan, now manager of the department of shop labor of the New York Central, handled the throttle on the record-breaking run.

The steel industry looks to the railways to keep it in a healthy, normal condition for some time to come, in the opinion of Charles M. Schwab, as stated in a recent interview. He pointed out that normally the railways use about one-third of all the steel produced. For the past five years railway purchases have fallen far below this average, and Mr. Schwab believes that a steady production of steel for several years will be necessary to make up this deficiency, even if orders from other sources fall off.

The proceedings of the annual meeting of the Mechanical Section of the American Railroad Association held in Atlantic City, N. J., June 9-16, 1920, are now ready for distribution and may be obtained from the secretary, V. R. Hawthorne, Chicago. The Rules of Interchange and Tank Car Specifications, as revised at the annual meeting, have been approved by the Executive Committee and will be ready for distribution in a short time. The new rules and specifications will become effective November 1, 1920.

Out of an order, handled by the Dutch Colonial Office, for 82 locomotives for the Java State Railways, 58 went to German builders and 24 to Dutch builders, who will obtain much of the needed material from the Germans. The order includes 2-8-2, 4-6-2 and 2-4-2 locomotives of a fair size. An American concern tendered bids on the 2-8-2 engines, but lost the order to the Germans as the latter offered the same deliveries and agreed to build at a price which was 40 per cent lower, under the existing rate of exchange, than the price of the American bidder.

Shop Tools

The Southern Pacific, Texas & Louisiana Lines have authorized the expenditure of $700,000 for the purchase and installation of shop tools.

Russia Contracting with German Locomotive Manufacturers

London.

It is stated in the Dagens Nyheter that the Russian representative, Professor Lomonosov, recently visited Berlin, where he made a contract with the Locomotive Manufacturers' Trust for the delivery of 1,500 locomotives within one year. It is stated that the Saxon Engineering Company, formerly Richard Hartmann & Co., of Chemnitz, has received an order for some of these locomotives to the value of 30,000,000 marks (approximately $500,000).

Belgian Railways Approach Normal Again

Belgian railways are steadily being restored to normal, according to a report received at Washington from Trade Commissioner Samuel H. Cross at Brussels. Several of the lines put out of commission by the war have been completely restored. The repair shops report their efficiency at 50 per cent of that of the pre-war days. A premium system for enginemen to encourage economy in repairs and fuel consumption is reported to be producing favorable results.

Recent Locomotive Orders

The Western Maryland has ordered 40 Consolidation locomotives from the Baldwin Locomotive Works.

The Illinois Central has ordered 25 switching locomotives from the Baldwin Locomotive Works.

The Paris-Orleans has ordered 50, 4-6-2 type locomotives from the American Locomotive Company.

The Canadian Pacific has ordered 15 Mikado type locomotives from the American Locomotive Company. These locomotives will have 25½ in. by 32 in. cylinders and a total weight in working order of 320,000 lb.

The Market for Cars in Cuba

That Cuban sugar mills are large owners of rolling stock is pointed out by Trade Commissioner H. A. Chisholm in a recent report to the Canadian Department of Trade & Commerce from Havana. There are 193 sugar mills operating now in Cuba and it is estimated that they own 15,000 cane cars and 600 locomotives. Most of the railway lines operated by these mills are of standard gage. American cars are favored in the Cuban tariff by a re-

duction of the ad valorem duty from the 31.25 per cent, which manufacturers of other nations must pay, to 11.25 per cent. This gives American manufacturers a decided advantage over foreign competitors. Some Cuban railways are, however, under British control and there is a disposition to favor British bidders when it can be done without increased cost.

Shop Construction

Atchison, Topeka & Santa Fe.—A contract has been let by this company to J. E. Nelson & Sons, Chicago, to construct a machine shop at Albuquerque, N. Mex., to cost approximately $1,250,000. This shop will be the central structure of a group of six other buildings to be constructed later. This building will be constructed of steel and glass and will have a composition roof and a mastic floor. There will be 26 engine pits. It is to be heated by a fan system placed in the upper structure.

China Standardizing Its Railways

The Chinese Ministry of Communications is making good progress in determining standards for the government railways of that country. The Commission on Railway Technics was organized in 1918 to make observations and recommendations regarding standards for all phases of railway work. It is expected that, once uniform materials and equipment are decided upon, those manufacturers who can supply the specified materials most efficiently will secure the Chinese trade. The Ministry desires to have some of the railway supply industries locate in that country if possible.

Chilean State Railways Poorly Equipped

Reports from Valparaiso say that the Chilean State Railways have reached their maximum carrying capacity, which meets about half of the transportation needs of the country. Owing to the difficulty of negotiating a foreign loan for the purchase of equipment abroad, the government is being urged to stimulate the manufacture of railway supplies in Chile. It has been about eight years since new equipment in large quantity has been purchased. In the meantime needs for new rolling stock to provide for additional business and for deteriorated equipment have grown apace.

Freight Car Orders

The Northern Pacific has ordered 93 caboose cars from the Pacific Car & Foundry Company.

The Gulf Coast Lines have ordered 500 box cars and 50 tank cars from the American Car & Foundry Company and 400 gondola cars from the Mount Vernon Car Manufacturing Company.

The Western Pacific has ordered 700 50-ton composite general service cars from the Pressed Steel Car Company.

The Wheeling & Lake Erie has ordered from the Standard Steel Car Company 1,500 50-ton steel gondola cars; from the Pressed Steel Car Company, 500 50-ton steel gondola cars and 500 40-ton box cars; and from the American Car & Foundry Company, 500 40-ton box cars.

Air Brakes on Swedish Railways

It is now announced that the Kunze-Knorr air brake, a German invention, with which the rolling stock of the State Railways in Sweden are to be equipped, will involve an expenditure of no less than 30,000,000 crowns, which at normal rate of exchange represents $8,150,134.

The railway officers estimate the annual saving from the use of this particular air brake at 5,500,000 crowns, or $1,474,530 at normal exchange, and this because of the consequent reduction in the number of railway employees. These Kunze-Knorr air brakes are to be made in Sweden, Aktiebolaget Nordiska Armaturfabrikerna, at Lund, having made a contract with the German company to manufacture them.

The Swedish private railroads have been reluctant to adopt air brakes, but it is probable that sooner or later they will follow in the footsteps of the State Railways. It would, therefore, be well, says Consul General Dominic I. Murphy, who sends the above information to Commerce Reports, for American manufacturers of air brakes to get in touch with the private railroad companies in Sweden, as it is quite certain that the German company cannot undertake to equip them at least for a year or two.

School for Railway Employees in Berlin

Berlin, Germany.

A school for railway employees was founded in Berlin about a year ago and the first annual meeting was held on July 15, 1920. At this meeting it was stated that owing to the success of this school, 20 branch schools were opened in the Prussian-Hessian railroad district during the year and that about 18,000 pupils are registered. It is planned to open a further 36 schools in the near future. It is the aim of the school to give all progressive employees the possibility of further education. It therefore has established courses on general educative subjects given by well-known teachers of high schools and universities, and in addition special courses on railway matters. As both the workers and the employees' trade unions are in favor of and are co-operating in the scheme, the government has declared its willingness to promote and further the movement as far as possible.

Modifications in Prices in Interchange Rules

The mechanical Section of the American Railroad Association has issued circulars S III-166 and S III-168 announcing changes in the labor rates for repairing foreign cars and in the maximum amount of labor chargeable to cars under Rule 120. Circular S III-166 reads as follows:

Since Supplement No. 3 to the 1919 Rules of Interchange was prepared and approved, the labor rates paid by the railroads to employees engaged in car repairs have been increased. Therefore, effective September 1, 1920, the rates to be charged for labor repairing foreign cars shown in Supplement No. 3, 1919 Rules of Interchange, effective same date, are modified as follows:

Freight Car Code.—Rule 101, Item No. 172, labor rate for ordinary car repairs; changed from $1.00 to $1.20 per hour. Rule 107, Item No. 443, labor rate for repairing and testing steel tanks of tank cars, changed from $1.25 to $1.45 per hour.

Passenger Car Code.—Rule 21, Item No. 19, labor rate on lubrication; changed from 70 cents to 90 cents per hour. Rule 21, Item No. 20, labor rate for repairing passenger equipment cars; changed from $1.10 to $1.30 per hour.

These labor charges, in addition to including the actual labor cost of performing the work, include the following items of indirect expense:

Wages of foremen, work inspectors, clerks, laborers, etc., working on freight repairs.

Proportion of the expense of operating power plant and of wages of shop or gang foremen, shop clerks, etc., whose time is not charged direct to freight repairs.

Shop switching, including repairs, depreciation, interest, taxes, fuel, lubrication, water, other supplies, fuel station and enginehouse expenses, wages of enginemen and firemen, switch crews and switch tenders.

Proportion of salaries and expenses of G. S. M. P. and M. clerks, S. M. P. and M. and clerks, master mechanics and clerks and general foremen.

Circular III-168 increases the limits for labor in Rule 120, as shown in Supplement No. 1 to the 1919 Rules of Interchange, issued March 1, 1920, to conform with the increase in the labor rate for car repairs, as shown in Supplement No. 3 to the 1919 Rules and Circular No. 166, effective September 1, 1920:

Rule 120. Repair limits for labor:

REFRIGERATOR CARS	
Wooden, with trucks of less than 60,000 lb. capacity	$108.00
Wooden, with trucks of 60,000 lb. capacity and over	180.00
Wooden, with trucks of 60,000 lb. capacity and over, equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills, or steel underframe	270.00
HOUSE AND STOCK CARS	
Wooden, with trucks of less than 60,000 lb. capacity	45.00
Wooden, with trucks of 60,000 lb. and over	108.00
Wooden, with trucks of 60,000 lb. capacity and over, equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills, or steel underframe	225.00
All steel, or steel superstructure frame with steel underframe	315.00
GONDOLA AND HOPPER CARS	
Wooden, with trucks of less than 60,000 lb. capacity	45.00
Wooden, with trucks of 60,000 lb. and over	108.00
Wooden, with trucks of 60,000 lb. capacity and over, equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills, or steel underframe	180.00
All steel, or steel superstructure frame with steel underframe	270.00
FLAT CARS	
Wooden, with trucks of less than 60,000 lb. capacity	45.00
Wooden, with trucks of 60,000 lb. capacity and over	72.00
Wooden, with trucks of 60,000 lb. capacity and over, equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills, or steel underframe	180.00

In view of the fact that the Rules of Interchange as revised at the Annual meeting of the Section held at Atlantic City, June 9 to 16, 1920, will be issued in such a short time, no additional supplements will be issued to the 1499 Code.

Welding Society Decides to Form New York Section

The American Welding Society called a special meeting of its New York members on October 14, at the Engineering Societies building, for the purpose of forming a Metropolitan section of the society. About forty members were present at the meeting, which was presided over by Comfort A. Adams, past president of the society. Temporary officers were chosen and a nominating committee was appointed for the purpose of choosing permanent officers for the local section at its first regular meeting, held on October 25, at 4 p. m., in the same building. Sections of the society have already been formed in Philadelphia, Chicago, Cleveland and Pittsburgh. The New York section began its career with 125 members who have been transferred from the parent association to the local section.

MEETINGS AND CONVENTIONS

Master Boiler Makers' Association.—The thirteenth annual convention of the Master Boiler Makers' Association will be held at the Planters' Hotel, St. Louis, Mo., May 23 to 26, 1921, inclusive.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.
Section III.—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railroad Association, Section VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. B. Baker, Terminal Railroad, St. Louis, Mo.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411 C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting November 9. Paper on How to Heat Railway Buildings Economically will be presented by R. H. Black, Engineer Power Plant Construction, Grand Trunk Railway System, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Next meeting November 11, Hotel Iroquois, Buffalo, N. Y. Paper on Engine House Organization will be presented by E. R. Webb, M. M., M. C. R. R., St. Thomas, Ont. Annual dinner in the evening.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting November 9. Annual banquet and election of officers. Musical entertainment, speeches by members, etc.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va. Next meeting November 8-9, Atkin Hotel, Knoxville, Tenn. Paper on Hand Brakes and Why They Should Be Maintained will be presented by M. S. Belk, General Air Brake Instructor, Southern Railway. There will also be a discussion on shop kinks; Recommended Practice as to Air Brakes as adopted by the A. R. A. and the Air Brake Association.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 23 to 26, 1921, inclusive, Planters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting November 11. Paper on The Locomotive Terminal as an Operating Factor will be presented by L. G. Plant, Associate Editor, *Railway Mechanical Engineer*.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Next meeting November 19. Paper on Loss and Damage to Freight will be discussed.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Meetings third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Friday in month except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Next meeting November 12. Paper on the Manufacture of Steel by the Cambria Steel Company will be presented. Motion pictures.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, Chicago. Next meeting November 15

PERSONAL MENTION

GENERAL

C. E. Brooks, superintendent motive power of the Grand Trunk Pacific, with headquarters at Winnipeg, Man., has been appointed mechanical assistant of the locomotive department of the Canadian National and the Grand Trunk Pacific, with headquarters at Toronto, Ont. Mr. Brooks will assist S. J. Hungerford, vice-president, in mechanical matters and attend to other duties as assigned. G. E. Smart, general master car builder at Toronto, has been appointed mechanical assistant in the car department to assist Mr. Hungerford in mechanical matters also.

J. J. Connors, who has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Col., was born at Milwaukee, Wis., in 1860, and entered railroad service in 1875 in the shops of the Chicago, Milwaukee & St. Paul, at Milwaukee. During the next 43 years he served continuously with the St. Paul, being promoted successively to foreman, general foreman, master mechanic and assistant superintendent motive power. In 1918 Mr. Connors became general superintendent of the Morrison Foundry Company, the position he held at the time of his recent appointment.

Robert D. Hawkins, who has been appointed general superintendent of motive power of the Atlantic Coast Line with headquarters at Wilmington, N. C., as noted in last month's issue, was born on May 22, 1873, at La Fayette, Ind. He graduated from the School of Mechanical Engineering at Purdue University in 1893. He began railroad work in August, 1899, with the Great Northern as chief draftsman. Afterwards he became mechanical engineer, then general master mechanic and later assistant superintendent of motive power. He was promoted to superintendent of motive power on March 10, 1910, and retained that position until October 20, 1917, when he entered military service and was commissioned lieutenant-colonel, being assigned to Russia with the Railway Engineers. While in Russia he was given command of the Mechanical Section of Railway Engineers under the command of Colonel Emerson. He returned to the United States on January 5, 1920, and was appointed an assistant to the president of the Great Northern, doing special work in connection with mechanical matters. He held that position until his recent appointment.

R. D. Hawkins

Charles James, mechanical superintendent of the Hornell region of the Erie with headquarters at Hornell, N. Y., has been transferred to the Ohio region with headquarters at Youngstown, O., succeeding A. G. Trumbull, resigned. F. H. Murray, shop superintendent at Susquehanna, Pa., has been appointed to succeed Mr. James and J. Topp, general foreman at Susquehanna, has been appointed Mr. Murray's successor.

M. Sheffer, road foreman of engines on the Chicago, Great Western, with headquarters at St. Paul, Minn., has been appointed trainmaster of the Northern division, with the same headquarters, succeeding G. J. Congden, who has resigned. A. K. Rowe succeeds Mr Sheffer.

Charles Wheeler, whose appointment as supervisor of fuel and locomotive performance of the New York Central, with headquarters at Buffalo, N. Y., was announced in the *Railway*

Mechanical Engineer for August, was born on September 6, 1881, at Clyde, N. Y. He attended the Clyde High School and entered the service of the New York Central on April 1, 1901, as a fire cleaner. On September 1, 1901, he was promoted to engine watchman and in October, 1902, became a locomotive fireman. In February, 1907, he was promoted to locomotive engineman; in April, 1909, was appointed division air-brake inspector; and in May, 1918, road foreman of engines. He held this latter position until July 16, 1920, when he was appointed to his present position.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

T. M. Allison has been appointed road foreman of engines on the Northern Pacific, with headquarters at Pasco, Wash., succeeding C. A. Wirth, whose promotion to master mechanic, with headquarters at Pasco, was announced in the September issue.

C. L. Emerson, division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Ia., has been transferred to the Chicago terminal, with headquarters at Chicago. Mr. Hopper will succeed at the Chicago terminal F. Hopper who has resigned.

R. C. Hempstead, division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Madison, Wis., has been transferred to the Kansas City division, with headquarters at Ottumwa, Iowa, succeeding C. W. Taylor, who has been assigned to other duties. W. C. Kenney succeeds Mr. Hempstead at Madison.

T. S. Lowe has been appointed assistant master mechanic of the Canadian National Railways at Montreal, succeeding John M. Kerr, transferred.

E. H. McCann has been appointed master mechanic of the eastern division of the Chicago Great Western, with headquarters at Stockton, Ill.

James Simpson, whose promotion to general master mechanic of the Northern Pacific lines, west of Paradise, Mont., with headquarters at Tacoma, Wash., was announced in the September issue, was born at Shrewsbury, England, on September 26, 1859. He entered railroad service in 1879 as a machinist apprentice in the shops of the Michigan Central at Jackson, Mich. From March, 1883, when he became a machinist at Brainerd, Minn., Mr. Simpson has been continuously in the service of the Northern Pacific. In 1885, he was transferred to Mandan, N. D., where he was employed as machinist until 1890, when he was promoted to night foreman, with headquarters at Jamestown, N. D. Three years later he was appointed machine shop foreman at Mandan and he was later transferred to Fargo, N. D. In 1897 he was promoted to general foreman at Mandan and afterwards was transferred to Staples, Minn. In June, 1907, he was promoted to master mechanic with headquarters at Dilworth, Minn. He was transferred to Livingston, Mont., in 1912, and in October, 1918, was appointed master mechanic of the Idaho division, with headquarters at Spokane, Wash., the position he held at the time of his recent promotion.

SHOP AND ENGINEHOUSE

A. B. Clark, master mechanic on the Southern division of the Chicago Great Western, with headquarters at Des Moines, Iowa, has been promoted to superintendent of shops, with headquarters at Oelwein, Iowa, succeeding M. H. Oakes. H. Brinkman succeeds Mr. Clark.

G. Lamberg, whose appointment as shop superintendent of the Chicago, Milwaukee & St. Paul at Minneapolis, Minn., was announced in the September issue, was born on May 18, 1874, in Sweden. He attended the high school at Waukesha, Wis., and entered the employ of the Atchison, Topeka & Santa Fe on February 1, 1891, as a machinist apprentice. From 1896 to 1897, he worked as a machinist for the Chicago Great Western at St. Paul, Minn., when he was promoted to gang foreman. In 1899 he entered the employ of the Great Northern at St. Paul as a machinist. In 1903 he was promoted to roundhouse foreman at Larimore, N. D., and in 1904 became gang foreman at St. Paul. In 1908 he was promoted to shop superintendent at Havor, Mont. In February, 1909, he entered the service of the Chicago, Milwaukee & St. Paul as a machinist at Minneapolis. In 1910 he was appointed assistant roundhouse foreman; in 1912, gang foreman; in 1914, machine shop foreman, and in 1918, general foreman. On September 1, 1919, he became division master mechanic of the Aberdeen division at Aberdeen, S. D., which position he held until his recent appointment.

John Todd, shop superintendent of the Erie at Susquehanna, Pa., was born on December 18, 1886, at Glasgow, Scotland. He graduated from the high school at Cornell, N. Y., and, in December, 1908, entered the service of the Erie as a machinist. On September 30, 1909, he became machine foreman at Galion, O., and on November 1, 1911, was transferred to Marion, O. On November 1, 1912, he was transferred back to Galion as machine and erecting foreman. On October 1, 1916, he was promoted to general night foreman at Port Jervis, N. Y., and on February 1, 1917, he became general foreman at Marion, O. On June 1, 1919, he was transferred to Susquehanna, Pa., where he held the position of general foreman until his recent appointment as shop superintendent.

PURCHASING AND STOREKEEPING

U. K. Hall, general storekeeper of the Union Pacific, with headquarters at Omaha, Neb., has been appointed general supervisor of stores of the Union Pacific System, with the same headquarters. This is a newly created position having to do with the development of policies, the organization and plans to be followed, in a general way, by the stores organization of the Union Pacific System. The actual details of the plans to be followed out will be executed by the general storekeepers of the units comprising the system so that the general supervisor of stores will act only in an executive and directing capacity, reporting directly to the assistant to the president. Mr. Hall's entire career has been with the lines comprising the Union Pacific System, with the exception of eighteen months spent in Washington as associate manager of the Stores Section of the Railroad Administration. Mr. Hall was born in 1878 at Portland, Ore., and entered the employ of the Union Pacific System in 1897 as an office boy in the office of the purchasing agent. In 1899 he was transferred to the stores on construction work and in 1900 to the accounting department, occupying various positions on roadway, engineering and stores accounts. In 1904 he returned to the stores department and in 1912 was promoted to the position of general storekeeper of the Oregon-Washington Railroad and Navigation Company at Portland. In 1916 he was transferred to Omaha as general storekeeper of the Union Pacific. He will be succeeded in this position by O. Nelson, traveling storekeeper with headquarters at Omaha.

William W. Morris, who has been appointed purchasing agent of the Northwestern region of the Pennsylvania System, with headquarters at Chicago, succeeding I. B. Thomas, was born in Philadelphia, Pa., on October 3, 1879, and entered railroad service as a clerk in the general offices of the New York, Philadelphia & Norfolk, at Philadelphia, on November 1, 1896. In 1898 he became clerk to the secretary of the Norfolk & Portsmouth Belt Line. in addition to his duties in the office of the president of the New York, Philadelphia & Norfolk. Four years later he was made chief clerk in the purchasing department of the New York, Philadelphia & Norfolk, and at the same time became chief clerk to the auditor of the Norfolk & Portsmouth Belt Line. In January, 1909, when the New York, Philadelphia & Norfolk was taken over by the Pennsylvania, he was transferred to the purchasing department of the latter road, with headquarters at Philadelphia, where he remained until February, 1918, when he accompanied Samuel Porcher, purchasing agent of the Pennsylvania Railroad, to Washington. During his service with the Railroad Administration, Mr. Morris was made secretary to the Central Advisory Purchasing Committee, and later, when that committee was abolished, became assistant to the Director of Purchases. When the roads were returned to private control, on March 1, 1920, he returned to the Pennsylvania as assistant to the general purchasing agent, with headquarters at Philadelphia, the position he held at the time of his recent promotion.

E. V. Reinhold, assistant to the manager of purchases and stores of the New York Central Lines, with headquarters at Buffalo, N. Y., has been appointed assistant purchasing agent, in charge of fuel, of the New York Central Railroad, with headquarters at New York.

SUPPLY TRADE NOTES

Horace B. Hench, vice-president of Templeton, Kenly & Co., Ltd., Chicago, has resigned.

The Easton Car & Construction Company, Easton, Pa., has opened a branch office in the Railway Exchange building, Chicago.

F. Rodger Imhoff, field engineer at Detroit, Mich., for the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa., has been appointed sales manager.

A. E. Harrold has been appointed manager of railway sales of the Willard Storage Battery Company, with headquarters at Cleveland, Ohio. Mr. Harrold was born on February 19, 1883, and is a graduate of the electrical engineering course of the Pennsylvania State College. From 1907 to 1908 he served as assistant instructor at the Massachusetts Institute of Technology, and then for three years as director of the testing section of the National Lamp Works of the General Electric Company. From 1911 to 1914 he was electrical engineer of the Wood & Spencer Engineering Company, Cleveland, and since 1914 has been employed by the Willard Storage Battery Company as manager of its stationary battery department.

A. E. Harrold

Fred J. Passino, assistant district manager of the New York territory of the Independent Pneumatic Tool Company, Chicago, has been appointed district manager at Pittsburgh, Pa.

Clarence C. Brinley has joined the Conveyors Corporation of America as eastern manager of the trolley carrier department and will be attached to the New York office, 110 West 40th street.

Arthur F. Wallace, for many years prior to the war, manager of the Economic Machine Company, Worcester, Mass., has been appointed sales manager of the Metal Saw & Machine Company, Inc., Springfield, Mass.

The American Car & Foundry Company, Madison, Ill., has awarded a contract to the Wimmer Construction Company, St. Louis, Mo., for a new one-story spring works building, to cost approximately $50,000.

R. G. Berrington, formerly with the Cleveland Twist Drill Company, is now Cleveland sales manager for the Reed-Prentice Company, the Becker Milling Machine Company and the Whitcomb-Blaisdell Machine Tool Company.

Carl J. Schmidlapp and Allan A. Ryan have been elected members of the board of the Chicago Pneumatic Tool Company, New York. Mr. Schmidlapp takes the place of A. F. Cassidy and Mr. Ryan fills a vacancy that had existed in the board for some time.

M. A. Kretchmar, chief lubricating engineer of the Sinclair Refining Company, Chicago, has become associated with the Horrocks Company, Herkimer, N. Y., as supervising engineer in charge of equipment and sales promotion work. The Horrocks Company manufactures the Danight lubricator.

The Keith Railway Equipment Company, Chicago, is completing a new steel freight car shop at Hammond, Ind., which involves an expenditure of $300,000. The extension will give to the company complete facilities for building and repairing both steel and wooden freight cars, and tank cars.

E. Payson Blanchard, a mechanical engineer, for several years advertising manager of the Boston Pressed Steel Company, Worcester, Mass., has resigned to go with the Bullard Machine Tool Company, Bridgeport, Conn., where he will take a shop course before entering the sales and advertising departments.

F. F. Fitzpatrick, president of the Railway Steel-Spring Company, New York, has received the decoration of Officer of the Crown of Italy. This order was founded in 1868 by King Victor Emmanuel II and is given as a reward for signal merit to military officers and others who have performed distinguished service in Italy.

The Lancaster Steel Products Corporation, Lancaster, Pa., recently opened a New York office in the National Association building, 25 West Forty-third street. The office is in charge of L. E. Vesey, as district sales manager. Mr. Vesey, for the past year and a half, has been in the Chicago office of this company.

The Norton Company, Worcester, Mass., has opened a branch office for its grinding machine division in room 304 Fenway building, 241 North Pennsylvania avenue, Indianapolis, Ind., under the direction of Walter F. Rogers, district representative. The establishment of this branch office will in no way affect the distribution of Norton grinding wheels. These will be handled as in the past by the Vonnegut Hardware Company.

A. L. Whipple has been appointed representative of the Locomotive Stoker Company, Pittsburgh, Pa., with offices at 50 Church street, New York. In 1888 Mr. Whipple entered the service of the Fitchburg Railroad, of which he was later assistant to the purchasing agent. He subsequently served as assistant superintendent of the Hoosac Tunnel & Wilmington Railroad, from which position he entered the railway supply field as representative of the Boston Woven Hose & Rubber Company, and then went to the Curtain Supply Company, Chicago, as general sales agent. In 1907, he was sales manager for Forsyth Brothers Company, Chicago, and in 1913, vice-president of the Standard Heating & Ventilating Company. Mr. Whipple served as entertainment committee chairman of the Master Mechanics' and Master Car Builders' conventions in 1904 and 1905, and vice-president of the Railway Supply Manunfacturers' Association in 1908. Before becoming connected with the Locomotive Stoker Company he was vice-president and acting general manager of the Railway Improvement Company, New York City.

A. L. Whipple

The Skinner Chuck Company, Inc., New Britain, Conn., has recently adopted a new trade mark. It shows an alligator in the form of the letter "S," superimposed on a solid black circular background, with the words "Skinner Chucks" around the outside. The alligator was chosen as the symbolic figure best suited to the exploitation of Skinner Chucks, because the alligator is famous for its wonderfully strong jaws and long life.

The Safety Car Heating & Lighting Company and the Pintsch Compressing Company have removed their sales service, treasury and engineering departments from 2 Rector street, New York, and the purchasing, accounting and manufacturing departments from Jersey City, N. J., to their new plant at the corner of Dixwell and Putnam avenues, New Haven, Conn. The executive offices and sales office for the northeastern district will be located at 2 Rector street, New York, as heretofore.

R. A. Bull, vice-president of the Duquesne Steel Foundry Company and former president of the American Foundrymen's Association, has resigned to become consulting metallurgist for the Electric Steel Company, Chicago; Fort Pitt Steel Castings Company, McKeesport, Pa.; Isaac G. Johnson Company, Spuyten Duyvel, N. Y.; Lebanon Steel Foundry Company, Lebanon, Pa.; Michigan Steel Castings Company, Milwaukee, Wis.; and the Sivyer Steel Castings Company, Milwaukee, Wis.

The St. Louis Pump & Equipment Company, engineers and manufacturers, has been organized, with headquarters at St. Louis, Mo., to manufacture and install liquid handling equipment, specializing in units for gasoline and oil, measuring devices, etc., especially adapted to railroad and industrial use. The company has opened executive offices in the International Life building and temporary factory space has been secured in the western industrial section of St. Louis. C. C. Fredericks, of Ft. Wayne, Ind., has been elected general manager, and John C. Roberts, Jr., is president. Others affiliated with the company are: Willard D. Smith, Sherwood Hines and J. S. Farrell.

C. H. Jackman has been appointed sales agent of the Pressed Steel Car Company and Western Steel Car & Foundry Company, western district, with headquarters at Chicago. Mr. Jackman was born at Crystal Lake, Ill., on May 5, 1893, and was educated at the University of Illinois, graduating in 1916. He entered the employ of the American Bridge Company at Gary, Ind., as a draftsman in the master mechanic's department. Later he was with Joseph T. Ryerson & Son, Chicago, as estimator and sales correspondent until December 10, 1917, when he enlisted in the Air Service, U. S. A. After completing the army's course for pilots, he was commissioned Second Lieutenant, R. M. A. Upon receiving his discharge from the service, he returned to Joseph T. Ryerson & Son as special steel salesman, where he remained until his recent appointment as sales agent of the Pressed Steel Car Company and the Western Steel Car & Foundry Company.

American Car & Foundry Company

W. H. Sanford, for many years district manager of the Buffalo, N. Y., plants of the American Car & Foundry Company, New York, has been appointed assistant vice-president in charge of sales in the Buffalo district. This is in connection with the company's plan of extension in that district.

Prior to the formation of the American Car & Foundry Company, Mr. Sanford was employed by the Union Car Company, and when that company was absorbed he was appointed paymaster and cashier at the Depew plant. In 1902 he was appointed local auditor of the Buffalo district, followed by promotion to the position of resident representative. In 1912 he was made district manager in charge of the Depew and Buffalo plants.

Mr. Sanford has been succeeded as district manager by Andrew H. Gairns, who was district manager of the company in Chicago. He will direct the operation of the new plant in Buffalo, also the foundries located there and the plant at Depew. Mr. Gairns has had an extended experience in steel car work and locomotive building and is well qualified to take up the duties demanded by the Buffalo district.

The company's new plant now under construction in Buffalo will be used for building all-steel cars, with a capacity for turning out 20 to 30 cars a day. It will be equipped with the most modern machinery and labor-saving devices known, and there will be a number of features introduced which are entirely new and novel to the car building industry. In addition to the new car-building plant, a modern up-to-date office building will be erected on property recently acquired across Babcock street. The grey iron foundry at the Buffalo plant has been completely re-equipped and is now engaged in quantity production. The Niagara wheel department has also been brought up to a high state of efficiency.

At Depew, during the recent war, the company was the largest producer of 155 mm. shells. Immediately following the armistice, the entire Depew plant was reconstructed and is now capable of building 20 cars a day. E. G. Englehart is assistant district manager at Depew in charge of operations at that place, reporting to Mr. Gairns.

The car company's plans, as outlined above, involve a total expenditure of $3,500,000. With the developments that have taken place, the car company becomes one of the largest manufacturing operations in Buffalo and vicinity.

TRADE PUBLICATIONS

Temperature Controllers.—A small illustrated folder has been issued by the Foxboro Company, Inc., Foxboro, Mass., describing in detail their automatic temperature controllers.

Steel Lockers and Shelving.—The Van Dorn Iron Works Company, Cleveland, Ohio, has issued a pamphlet illustrating and describing the Van Dorn steel lockers and Van Dorn Simplex shelving.

The Oxygraph.—The Davis-Bournonville Company, Jersey City, N. J., has issued a new bulletin showing some details of their No. 1-A and No. 2 mechanically operated cutting torches for cutting steel up to 20 in. thick.

Link Belt Silent Chain Drives for Cement Mill Equipment.—The Link-Belt Company, Chicago, has ready for distribution a 32-page book, No. 345, which gives and substantiates reasons why the Link-Belt drive is ideal for operating ball mills, tube mills, conveyors, etc.

Price List.—Catalogue B-20 issued by the Armstrong Bros. Tool Company, Chicago, Ill., embodies and makes effective many changes in the list prices of the company's products. Attention is also called to the following additions to their line: Spring Threading Tool, Knurling Tool (3 new sizes), Bent Tail Heavy Duty Lathe Dogs, Aero Tappet Wrenches and Ford Wrench Sets.

Belt Lacing.—Under the title "Short Cuts to Power Transmission" the Flexible Steel Lacing Company, Chicago, has published a practical manual of belting practices. After discussing the factors to be considered in buying belts and describing the more important types in general use, the booklet covers the care of belts and the application of lacing. Valuable information concerning belt speeds, power transmitted, and the cause of belt trouble is given.

Balanced Draft.—"Modern Practice in Combustion Control" is the title of a booklet which has been issued by the Engineer Company, New York. This booklet contains 28 pages of interesting and instructive data of particular value to those interested in combustion. The science of combustion is treated at some length and consideration is given to some of the elements of combustion control. The principles of balanced draft and its many advantages are explained at length. A description of the apparatus and operation of balanced draft is given.

Water Softeners.—"Reap As The Harvester" is the title of a booklet published by the Graver Corporation, East Chicago, Ind., which describes the installation of Graver water softeners at the plant of the Wisconsin Steel Company and the savings effected by their use. In the second part of the book, the construction and operation of the Graver hot-process water softener is described. An interesting feature of the book is the series of artistic drawings of ore docks, blast furnaces and other equipment used in the manufacture of iron and steel.

Nonpareil Insulating Brick.—A 72-page illustrated book on the insulation of high temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens, kilns, etc., has been issued by the Armstrong Cork Company, Pittsburgh, Pa. The results of a study, from both theoretical and practical standpoints, on the subject of heat insulation compiled in this book make it a valuable and instructive treatise. It is conveniently divided into sections, each section dealing with a particular type of industrial apparatus.

Machinery Quarterly.—The first issue of the Machinery Quarterly by Joseph T. Ryerson & Son, Chicago, is now ready for distribution. This book is not intended as a complete machinery catalog, but does contain descriptive matter covering the line of equipment manufactured or sold by the Ryerson company. One or more machines or tools of each of the various classes are shown accompanied with brief descriptions and specifications. If the size or type of machine particularly desired is not shown, an illustrated bulletin with complete description and specifications will be forwarded on request.

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The Index for 1920

As a means of conserving paper during the war, only a limited number of copies of the index for the *Railway Mechanical Engineer* were published and these were distributed to subscribers upon request. This arrangement was apparently satisfactory to our readers and, as the paper shortage still exists, the same practice will be followed this year. Subscribers who wish to obtain a copy of the index should write to the Circulation Department of the *Railway Mechanical Engineer* so that the request will be received before January 1, 1921.

Locomotive "Terminal-ogy"

While the locomotive terminal is distinctly an operating factor and terminal management is truly an operation function, it is the mechanical equipment of the terminal that determines its capacity not only to maintain locomotives in good condition but to expedite their movement. There is a surprising variety of design in all terminal construction. It would be hard to find two ash pits alike on a single railroad and while there is still a preponderance of old inclined coal trestles in operation, modern coaling stations exhibit an infinite variety of design. Very few railroads have any well defined standards relating to enginehouse construction and equipment and these show such a wide divergence in character and completeness that it would be well to ask whether mechanical engineers could not profitably devote more time to a study of the various locomotive terminal facilities, not only on their own but on neighboring railroads, to determine what types are most effective and economical in operation. There is little question but that locomotive terminal facilities will undergo greater relative development in the next ten years than any other mechanical facility and it is important that mechanical engineers should be prepared to advise the railroads wisely in regard to the design and equipment of these facilities. It is a mistake to entrust the design of a new terminal wholly to the engineering department. It should be borne in mind that these facilities are to be used continuously by the mechanical department, and every terminal project should represent the best judgment of both mechanical and civil engineers. Moreover, in view of the true function of a locomotive terminal, the transportation department might well be consulted in regard to terminal improvements. What every railroad should do is to outline a broad, comprehensive plan that will take into consideration terminal needs for years to come. A committee representing the mechanical, engineering and transportation departments should be selected to study the problem and outline a plan to which all future construction should adhere.

What Every Mechanical Engineer Should Know

There is one activity of the government that should be better understood and more fully appreciated, particularly by mechanical engineers. This is the United States Patent office. Often regarded as an institution for protecting certain individual interests, it is in reality the greatest single factor in the mechanical development of the age. The railroads are particularly indebted to our patent laws for the rapid development of the many specialties that have made modern railroading possible. George Westinghouse would not have devoted so important a part of his career to the development of the air brake if he had not been assured of a proprietary interest in this invention by virtue of the patent law, nor could a mechanical engineer today afford to spend any considerable time or money in the development of an invention if he were not certain that his title to this invention would be clearly established. Very few industries could afford to devote years in perfecting a certain device if the improved device could

later be marketed or used by anyone without the payment of a royalty. The telephone, the electric light and practically every other mechanical achievement owe their development in part to our system of patent protection. It is not too much to say that our industrial development is entirely dependent upon the patent office. Any mechanical engineer who has recently been in touch with the United States Patent office knows that this branch of the government is presented with more work than it can handle expeditiously and that as the salaries of its technical experts have been maintained at a pre-war standard its work is handicapped by the loss of many good men who have been attracted to outside positions. It may require months to obtain decisive action on an important invention because the particular division to which the application is assigned has hundreds of applications ahead of it waiting to be acted upon. It is not generally known, however, that the fees attached to these applications considerably exceed the running expenses of the patent office and that a surplus is annually turned over to the Secretary of the Interior to be applied against the deficit incurred by some other department of the government. Not only the railroads and the industries that supply the railroads, but every mechanical engineer should individually feel concerned over the welfare of the patent office and should exert whatever influence he can bring to bear towards putting this important governmental activity upon the most efficient basis.

"The Monarch of the Rails"

So far from arriving at any definite conclusions concerning the relative merits of steam and electric traction, the recent discussion at a joint meeting of the Electrical and Mechanical Engineering Societies had the effect of confusing many of those who came to the meeting with fairly definite notions as to the characteristics of both modes of traction. Out of the host of generalities and maze of details presented at this meeting and abstracted elsewhere in this issue, a few really important conclusions as to the relative merits of steam and electric locomotives may be garnered. If one will disregard the comparisons attempted between modern electric locomotives and out-of-date steam locomotives or between electric locomotives operating under hypothetical conditions and imaginary steam locomotives operating under assumed conditions, he may find in parts of the discussion a statement of facts that shed real light on the ability of the electric locomotive to save coal. A representative of the N. Y. N. H. & H. stated that the coal consumption on the electrified section of that railroad over an extended period had averaged 9.3 lb. per car miles in passenger service and 84 lb. per 1,000 ton-miles in freight service. Even if Mr. Ralston had not stated that the coal consumption on steam locomotives over the same section of the line averaged 19.3 lb. per car-mile and 199 lb. per 1,000 ton-miles it would be evident to anyone familiar with steam locomotive practice that electric locomotives are actually hauling both freight and passenger trains in main line service with very much less coal than would be possible with the most modern steam locomotive operation. If representatives of the electrical manufacturers would confine their arguments to a simple statement of the actual coal consumption over an extended period upon the basis of ton and car-miles hauled, or where water power is utilized to convert this into an equivalent coal consumption they would have less difficulty in proving their contention that the electric locomotive can save coal. When it comes to a question of maintenance, the advantage of the electric locomotive is not quite so clear and the exponents of electrification are prone to overlook power plant maintenance as a factor to be reckoned with in connection with the electric locomotive. Broadly speaking, the electric locomotive is not "the monarch of the rails" as it has been described, but always a servant at the beck and call of the central power station whereas the steam locomotive is truly a self-contained unit and will always occupy a field by virtue of this fact that can never be invaded by its electrical rival. For an unbiased exposition of clear thinking on the entire subject we commend our readers to that part of the discussion contributed by W. L. Bean and A. W. Gibbs.

Fusion Welding An Art By Itself

The so-called fusion welding processes have received a remarkably rapid development and extension in the comparatively few years since their introduction as regular features of railway equipment maintenance. As a natural consequence of this rapid development a reaction has become evident in the minds of some of those who have to do with the results as applied to locomotive and car parts. This is not necessarily serious but it is a warning that the future extension of the art must be based on a far more thorough study of the conditions to be met by the welds, of welding methods and practices, and of the metallurgical aspects of welding, than has been devoted to the subject in the past. Fusion welding has passed through its pioneer development and must now be reduced to a science.

The greatest obstacles in the way of stabilization and sound future extension of these welding processes in the railroad shops are the provisions of the so-called National Agreement, which makes them mere adjuncts of the other crafts. Under this agreement welding must be performed by machinists, boiler makers, blacksmiths, tinsmiths and carmen, and by its provision, the qualifications which control in the selection of welders is seniority of employment as a craftsman in one of the other trades. Under these conditions it is manifestly impossible to maintain the degree of permanency in the welding forces essential to the development of highly skilled and experienced operators; the kind of work assignable to each welder limits his experience and outlook and the supervision is divided among the regular shop foremen, to none of whom welding is a primary interest.

The short time in which one may acquire a sufficient degree of skill in the manipulation of the torch or electrode so that he may "get by" is possibly one of the most potent factors in the rapidity with which the processes have come into general use. But it also constitutes one of the greatest dangers to sound future development. One of the best ways of avoiding this danger is to organize fusion welding work as a trade by itself, for training in which men may be selected who have the proper temperament and whose purpose is to make welding a permanent vocation. Not only will this lead to the develoment of more skilled operators, who in time will supplement their skill with more or less knowledge of the metallurgical questions involved, but better supervision will become possible because of the concentration of the work in a department by itself and because the craft training of the welders will provide the material from which competent supervisors may be selected. The possibilities for economy in the railroad shop offered by these processes are too great to permit the strangling of their future development by the permanent establishment of conditions under which they must now be applied.

Don't Neglect Your Pyrometers

One of the most important factors in insuring good tool service is a suitable complement of heat treating furnaces, so equipped that close regulation and accurate measurement of temperature is possible. One of the essential items of a tool treating installation is the pyrometer. Without this instrument the color method of judging temperatures must be depended upon and it has been demonstrated that the most skilled heat

treater is unable, under all conditions, to determine temperatures within limits of variation narrow enough to be permissible if uniform results are to be obtained. These facts have already been recognized by mechanical department officers of many railroads and where the conviction has been backed up by the installation of the equipment, gratifying results have generally been obtained. But in some cases there has been a tendency to assume that, once provided, such equipment needs no further attention. Where such an attitude exists the results are very likely to prove disappointing.

The pyrometer is a delicate instrument and care is required in its installation and its readings should be checked frequently if accuracy is to be insured. Otherwise the effect of its use may be even worse than if full dependence had been placed on the eye of the tool treater. Where the best results have been obtained it will generally be found that some means has been provided for periodically checking and calibrating the pyrometers. Some pyrometer manufacturers advocate the checking of these instruments at intervals not exceeding three months, not necessarily because the instruments are expected to require adjustment at such frequent intervals but as an insurance against the loss which might follow should an instrument for any reason get seriously out of adjustment. The periodical checking of these instruments offers no great difficulty and there are available at least three means from which to choose. Under most conditions probably the most satisfactory plan is to purchase a standard instrument which should be used only for comparisons with the service instruments and for special investigations in the test department. These instruments may be calibrated, say once a year, by sending them to the Bureau of Standards at Washington or to a commercial testing laboratory. Or, where the commercial testing laboratory is readily accessible it may be entirely practicable to send the service instruments themselves for periodical calibration. The pyrometer manufacturers in some cases are developing service organizations for the purpose of checking instruments of their own make without removing them from the shops where they are in use, a regular service which may be obtained for a nominal fee.

Whatever means may prove must practicable, it is important that the periodical calibration of pyrometers be provided for and insisted on if the maximum return on the investment is to be obtained from modern heat treating equipment.

What Do You Think?

The editors of the Railway Mechanical Engineer aim to present in each issue a sufficient variety of material to insure that every subscriber will find a number of articles that are of direct interest and value to him. Is the range of subjects covered in this issue great enough to give you the information that you are looking for? Let us look it over and see.

One of the principal articles describes a series of tests of the locomotive booster. No device that has been brought out in recent years has created as much interest as this. Here is the story of what it does in actual service.

A prominent electrical engineer has recently proposed the electrification of all the railroads north of Washington, D. C., and east of the Allegheny mountains. When such proposals are being made, railroad men will surely want to have a clear idea of what the change to electric operation could be expected to accomplish. The papers on the Relative Merits of Steam and Electric Traction will help in forming an opinion on this important subject.

The locomotive terminal is becoming more important as locomotives grow larger and more difficult to maintain. The article on the Locomotive Terminal as an Operating Factor was written with this thought in mind and is intended to give constructive suggestions for getting more service from the motive power.

The principal feature in the Car Department section is the report of the C. I. C. I. & C. F. A. convention. The papers and discussions show what the car men who are actually on the firing line are thinking and doing. Whether you are interested in yard or shop work, passenger or freight this will give you some new ideas.

Don't you suppose that your welders would do better work if their jobs were tested occasionally? The author of the article on testing welds is a practical man and a vise and a hammer are the only tools needed to make the tests he recommends.

Every shop and roundhouse man knows how much trouble is caused by cut flanges. The new method of curing this old trouble which was developed on the New York Central at West Albany is described in this issue.

These are only a few of the high spots; the rest of the articles are just as helpful in their special fields.

When New Year's Day arrives the editors will all resolve to make the Railway Mechanical Engineer better than ever next year. When you finish reading this issue we would like to have you sit down and write the editors telling them what you liked and what you did not like in the recent issues, and what they can do in the coming year to make, not their paper but YOUR paper, more interesting and valuable.

Poor Equipment and Operating Costs

Much has been said about the need for improvement in car conditions and everyone having to do with the maintenance of rolling stock is endeavoring to reduce the percentage of bad order cars. Unfortunately, however, the number of cars reported in bad order is a very poor measure of car conditions and their effect on operating costs. Only too frequently a campaign to reduce the percentage of bad order cars, instead of actually improving conditions, leads to a lowering of maintenance standards which has an adverse effect on the cost of operation. Many cars of weak construction are still in service and must be perpetuated for several years until enough new equipment can be financed and built to make up for the accumulated shortage of the war period. In laying out programs of re-enforcement there is a tendency to consider only the investment value of the equipment and many of the older cars are being permitted to remain in service until they are automatically retired by being broken up in service. Failures of such equipment cause innumerable delays to train movement with a heavy quota of crew overtime which must be paid for at time and one-half time. Their use leads to the destruction of freight, which must be paid for by the railroads, and adds a serious element of danger to train operation. The buckling of a car of weak construction in a heavy freight train, is almost sure to result in scattering equipment and freight alike all over the right of way. Such accidents are common and when their cost is added to the cost of overtime from train delays at terminals and on the road, caused by the necessity of switching out defective equipment, a field for economy will be found which justifies the extension of betterment programs well beyond the point fixed by considerations of capital expenditure, theoretical earning capacity and maintenance costs.

The Price of Government Ownership.—Disclosures in the United States Shipping Board investigation furnish convincing grounds for argument against government ownership and operation. While the investigation has not yet proceeded far enough to determine whether any blame for unnecessary expenditures rests with those in charge of the Board's affairs, enough has been revealed to show that governmental ownership and operation is a prohibitively costly luxury.—*Virginian Pilot and Norfolk Landmark.*

NEW BOOKS

Proceedings of the American Railway Tool Foremen's Association for 1919, 274 pages including advertising, 6 in. by 9 in., bound in cloth. Published by the Association, R. D. Fletcher, secretary-treasurer, 1145 East Marquette road, Chicago.

This book contains a complete transcript of the proceedings of the 1919 convention of the American Railway Tool Foremen's Association. This convention was the first to be held since 1916 and, despite unfavorable conditions existing at the time it was held, a number of very instructive papers were presented and thoroughly discussed. The value of the year book, however, does not lie wholly in its presentation of the proceedings of the convention, as it contains a number of well illustrated papers on jigs and special devices and tools which were received too late to be presented before the association during the convention. Many of these devices contain valuable suggestions for shop foremen other than tool foremen.

Data Book for Engineers. Published by the Locomotive Superheater Company, 30 Church street, New York. 79 pages, 4½ in. by 8 in., bound in flexible leather covers.

The most noticeable feature of this book is the ease and facility with which any required data or tables may be referred to. The book contains the data most frequently desired by steam or power plant operators with special reference to those in charge of superheated steam boilers. The first few pages of the book summarize the factors affecting the advisability of installing superheater units in saturated steam boilers. Fuel cost, engine performance, boiler maintenance, labor charges, steam-line losses and the relative first cost are among the factors considered. Tables showing the factors of evaporation, grate area per horsepower and the dimensions of various types of boilers are given; also additional tables showing the size of chimneys per boiler horse power, fan dimensions and dimensions of standard boiler tubes. Much additional instruction in the way of determining the flow of steam in pipes, calculating boiler horse power, speed of pulleys, etc., is given. For reference in solving problems, saturated and superheated steam tables are shown in the back of the book. All tables and information are conveniently arranged and can be readily located by means of a carefully arranged index.

Proceedings of the Master Boiler Makers' Association. Edited by Harry D. Vought, secretary of the association, 95 Liberty street, New York. 149 pages, 6 in. by 9 in., bound in cloth.

This book contains the official proceedings of the twelfth annual convention of the Master Boiler Makers' Association held at Hotel Curtis, Minneapolis, Minn., on May 25 to 28, inclusive, 1920. As customary, the first few pages of the book contain a list of officers for the year 1920-1921, subjects and committees for the 1921 convention, and a list of the members and guests who registered at the convention. The opening exercises and addresses are reported in full, together with reports of the secretary, Harry D. Vought, and treasurer, W. H. Laughridge. Committee reports, together with the complete discussions, are given in the book, including the report of the Committee on the Best Type of Washout Plug and four other important topics, as previously announced for consideration at the 1920 convention. In addition, there is included the address of Professor Alfred S. Kinsey, of Stevens Institute of Technology, and a paper on Electric Welding by Charles L. Hempel. The report of the Committee on Law and Resolutions is given and the latter part of the book is devoted to publication of the constitution and by-laws, together with the membership list and a list of the Women's Auxiliary.

Bituminous Coal Storage Practice. By H. H. Stock, C. W. Hippard and W. D. Langtry. Bulletin No. 116, Engineering Experiment Station, University of Illinois, Urbana, Ill., 150 pages, 6 in. by 9 in., bound in paper.

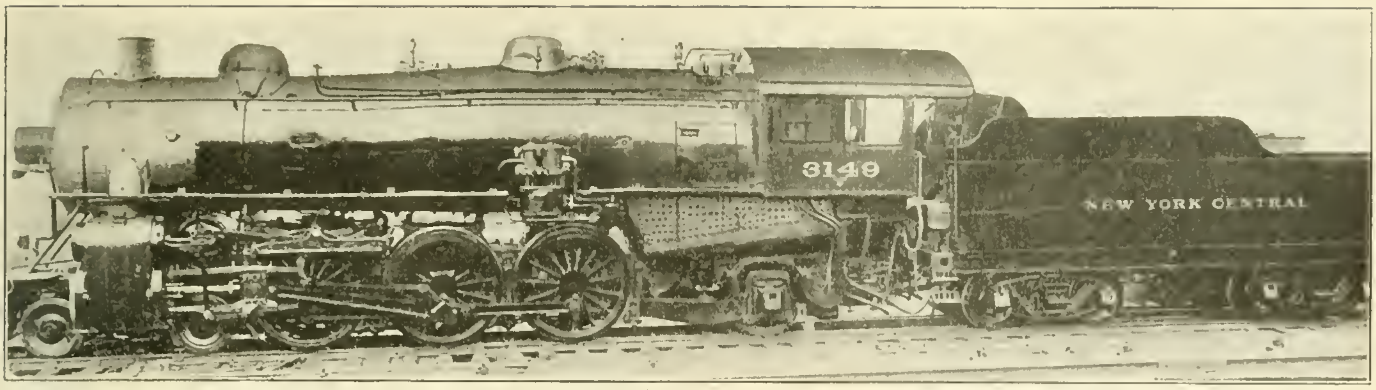
The growing inability to maintain a steady flow of coal from the mine to the consumer to take care of the fuel demands of the country currently, especially during the winter season, has attracted wide interest to the problem of storing large quantities of coal near the point of consumption. One of the most serious handicaps to the storage of bituminous coal is the constant danger of spontaneous combustion. A study of the causes of spontaneous combustion and methods of prevention has been undertaken by the Engineering Experiment Station of the University of Illinois and has been in progress for several years. Considerable information on the subject was included in Circular No. 6, on "Storage of Bituminous Coal," issued in 1918, and Bulletin No. 116, contains much additional information which has been obtained by a study of the circumstances surrounding a considerable number of fires in stored coal, as well as of methods of inspecting storage piles which have been followed with success in the prevention of fires. The results of these studies are given in detail and the bulletin is invaluable to any large user of coal who now has storage piles or contemplates the storage of coal in quantity.

The Making, Shaping and Treating of Steel, by J. M. Camp and C. B. Francis, Bureau of Instruction, Carnegie Steel Co. 600 pages, illustrated, 5 in. by 8 in. Bound in cloth. Published by J. M. Camp, Carnegie building, Pittsburgh, Pa.

The scope included by the title of this work naturally suggests a voluminous treatise. However, the authors have covered the comprehensive subject very well in a book of 600 pages by eliminating all non-essential matter. The book is frankly a description of the steel industry as it exists; it is not written from the viewpoint of the steel expert and comparatively little is said about the future development of the industry. For that reason, anyone thoroughly versed in the manufacture of steel might find little that is new in the book. For the railroad officer who desires a thorough knowledge of the steel industry and its most important products, the book is extremely valuable. Designed as a course of instruction for salesmen, this work necessarily includes practically all the information required by those who buy or use steel.

The book is strictly non-technical and opens with a discussion of the fundamentals of physics and chemistry as applied to steel making. The entire process from the ore to the finished product is then outlined in a systematic manner. The various ores, refractories, fuels, fluxes and slags are discussed and the manufacture of coke by the beehive and by-product processes is described. In the discussion of the making of pig iron, the construction and operation of the blast furnace and the chemistry of the process are covered. The Bessemer and open-hearth processes are treated in a similar manner, a short history of their development being included. Another chapter is devoted to the manufacture of steel in electric furnaces, which is followed by a description of the duplex and triplex processes. The section on the shaping of steel discusses chemical properties, describes the rolling mill and covers in some detail the rolling of blooms, billets, plates, rails and rail joints, the strip and merchant mill products, rolled steel wheels and axles.

The third part of the work treats of the constitution, heat treatment and composition of steel. The solution theory of steel is explained and the theory and practice of heat treatment are discussed with this as a basis. The concluding chapters are devoted to the effect of the common elements on the mechanical properties of carbon steel and a short description of the more usual types of alloy steel.



New York Central Pacific Type Equipped with Locomotive Booster

Tests of a Pacific Type Booster Locomotive*

Additional Tractive Effort of Booster Increases Tonnage Rating for Division on New York Central

"IDLE weight and spare steam harnessed in a simple way to do useful work at a critical time." This, in a few words, describes the locomotive booster which causes the trailing wheels to act as driving wheels in starting the train and to get it over the hard pulls on the road. For the past ten years or more locomotive designers have been striving for increased drawbar pull. Their efforts have increased the load per pair of drivers and the number of driving wheels until today the load limit that track and bridge structures will bear has been closely approached. In starting and foot of a momentum grade necessitates cutting loose and running for water. Stopping for signal or other cause on a hill may necessitate backing down to get started again. Loss of time in starting disrupts train schedules and often results in loss of train rights with consequent overtime, as well as increased operating costs.

Locomotives as ordinarily built today are hauling around a large percentage of weight that is useless except to permit of making the boiler larger. To permit train loading that would utilize a greater percentage of the available draw-

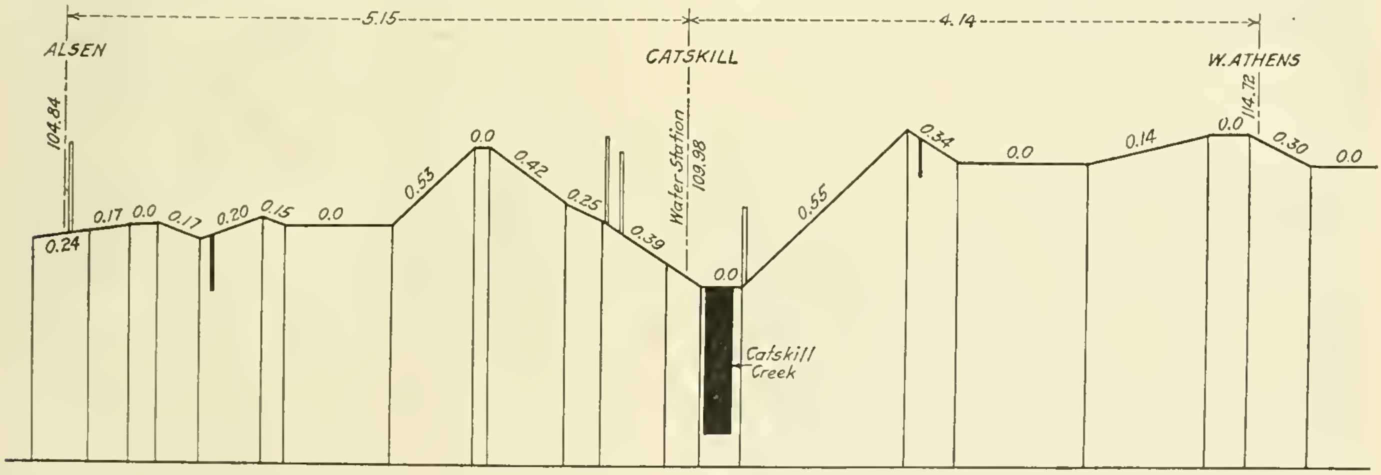


Fig. 1—Profile of West Shore Division at Catskill

at slow speeds every locomotive built has greater boiler capacity than it can utilize. While, of course, increased wheel loads and larger units mean greater tractive effort, the limiting factor, the ruling grade, determines the load a locomotive can haul over the division. To obtain maximum practical effectiveness from the locomotive and offset the tonnage limit imposed by the ruling grade several methods are in use. One is to station pushers at the foot of the grades to help the train over the hill; another is to make up the train, wherever possible, so as to drop several cars at some way point. Both are expensive and unsatisfactory.

Loading locomotives to the limit involves several other perplexing operating problems. A water plug located at the bar pull over the entire division and yet have sufficient power available for the critical points where extra power is needed led to the invention and development of the locomotive booster.

For approximately two years Engine 3149 equipped with the booster has been in operation on the New York Central. To determine the operating advantages of the booster, a series of tests was conducted on the River division between Ravena and Weehawken. This division is 130 miles long with a ruling grade of one per cent at Bogota going west and 0.46 per cent at Haverstraw going east. The locomotive used in these tests, 3149, is of the Pacific type with a load on drivers of 184,000 lb., steam pressure 200 lb. and a tractive effort of 40,000 lb. It was exhibited at the Atlantic City convention and has been in continuous road service since that time; no special preparations were made

*A description of the locomotive booster was published in the *Railway Mechanical Engineer* of May, 1920, page 265.

for the test. A dynamometer car was used to obtain the necessary data.

In making these tests information was wanted on the following items:

1. Practical increase in tonnage that could be hauled over the division because of the booster.
2. Effect of the booster on train operation over the division.
3. Maximum drawbar pull with the booster in action.
4. Maximum drawbar pull without the booster.
5. Time saved over the division because of the booster.
6. Increased train acceleration by use of the booster.
7. Effect of a crew, inexperienced with the booster, operating a locomotive equipped with a booster.

Test Results Going East

The first test was made going east from Ravena to Weehawken. Without the booster, Engine 3149 is rated from Ravena with 2,600 tons and runs to Newburgh where the tonnage is reduced to 2,100 tons, a reduction of 19.2 per cent. In making this test it was decided to endeavor to bring 2,582 tons through to Weehawken. This not only involved getting over the ruling grade at Haverstraw, but also introduced other interesting and important operating problems.

At Catskill the water plug is located at the bottom of two grades. It is the usual practice to leave the train at the top of the grade west of the water plug, run two miles for water, back up to the train and make a run down-grade to get sufficient momentum to carry over the up-grade. The profile of the road at this point (Fig. 1) shows a down-grade of

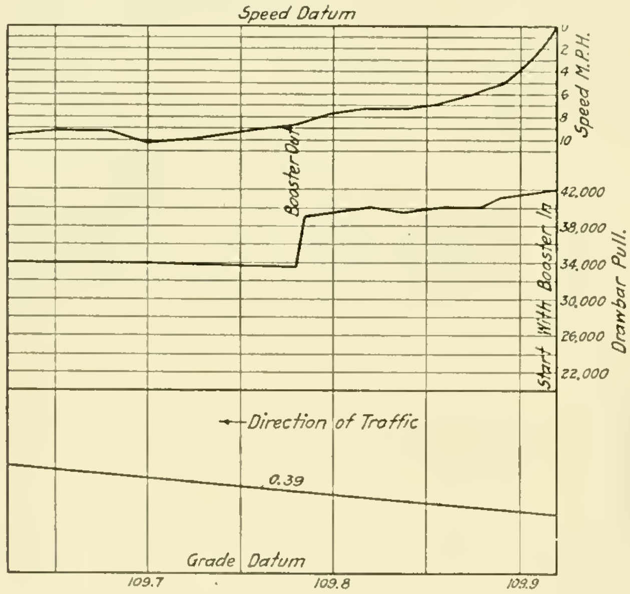


Fig. 2—Dynamometer Record of Booster Locomotive on Catskill Grade

0.55 per cent and an up-grade averaging 0.375 per cent. Running for water in this way consumes 20 to 30 minutes' time in good weather. When the weather is bad with sleet and snow 30 minutes' time is usually lost in pumping up the train line alone before the train can be started after coupling up, thus more than doubling the time lost.

In the test run the practice referred to was not followed. Engine 3149 hauled the train to the water plug intact, took water and started up the grade with the full train with the booster in operation. As shown by the dynamometer record (Fig. 2) the locomotive, with the booster in operation, accelerated to five miles per hour very quickly, the drawbar pull showing 41,067 lb. at this point and in a distance of 580 ft. the speed increased from 5 to 8½ m.p.h., or an increase of 70 per cent. When the booster was disengaged and the locomotive took the load entirely, the drawbar pull showed 33,497 lb., a difference of 7,570 lb.

Reference to Fig. 1 showing the road profile and Fig. 2

Ruling Tonnage for West Shore Division

Weehawken 0 miles	Cornwall 52 miles	Newburgh 57 miles	Kingston 88 miles	Ravena 129 miles
Tonnage Going East Without Booster				
....	....	2,100 tons	....	2,600 tons
Tonnage Going East With Booster				
2,582 tons	....	....	....	2,582 tons
Tonnage Going West Without Booster				
1,800 tons	....	2,100 tons	2,600 tons	....
Tonnage Going West With Booster				
2,015 tons	2,577 tons	....	2,745 tons	....

showing the dynamometer record clearly indicate the part the booster played in making possible the starting of the

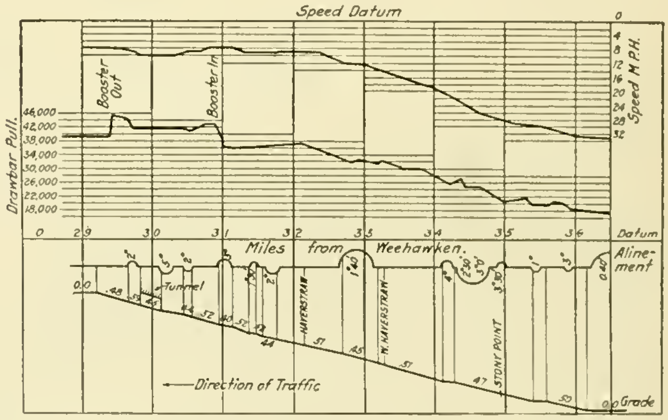


Fig. 3—Performance of Booster Locomotive With 22.6 Per Cent Excess Tonnage on Haverstraw Grade

train and getting up to speed on the grade; without the booster this performance would have been impossible.

At this point an important time saving operating situation developed. Because of the time saved at Catskill, West Point was reached just three minutes before an express was due. The express was followed to Weehawken, whereas usually two or three local passenger trains are allowed to go ahead. At times this adds another 30 minutes' delay in addition to the time lost at Catskill. After leaving Catskill the booster was used for starting whenever the train was stopped for signals or other reasons, each start showing rapid acceleration.

The ruling grade on this division is known as the Haverstraw grade (Fig. 3). It is over six miles long and the average gradient is about 0.46 per cent. This grade was approached at a speed of 33 m.p.h. with the booster idle and continuing up-grade the speed dropped as follows:

At the end of the first mile, 28½ m.p.h.

At the end of the second mile, 19 m.p.h.

At the end of the third mile, 12 m.p.h.

At the end of the fourth mile, 8 m.p.h.

At the fifth mile the speed was 7½ m.p.h. and falling rapidly. The drawbar pull was 36,441 lb. Without the assistance of the booster the train would have stalled.

At this point the booster was cut in on a 0.52 per cent grade, and in 432 ft. the speed reached eight miles per hour and the drawbar pull 42,900 lb., an increase of 6,459 lb. drawbar pull or 17.7 per cent because of the booster. In the first ¾ mile, after the booster was working, the speed reached 10 m.p.h. This shows an acceleration, because of the booster, in three-quarters of a mile of 33⅓ per cent with

a train tonnage 22.9 per cent above normal. In taking this train over the ruling grade the booster was used for about 1⅝ miles and just before being disengaged a drawbar pull of 45,080 lb. was recorded on the dynamometer car.

The train arrived at Weehawken with the same tonnage with which it started from Ravena. This was the first time this tonnage had ever been hauled over the entire division

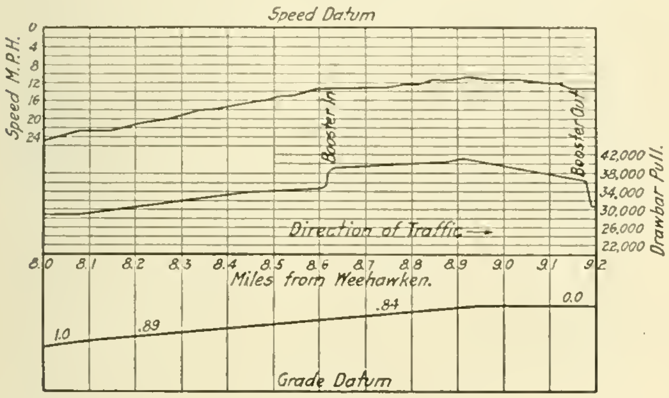


Fig. 4—Drawbar Pull and Speed Record Ascending Bogota Grade

by this type of locomotive. In addition no difficulty was experienced and the locomotive was handled by a crew not regularly assigned to the locomotive. Since this test was made the crew regularly operating this locomotive has hauled 2,618 tons over the division, an increase of 24.6 per cent over the regular tonnage.

Test Results Going West

By referring to the tabulated statement it will be noted that the tonnage rating of this locomotive without the booster

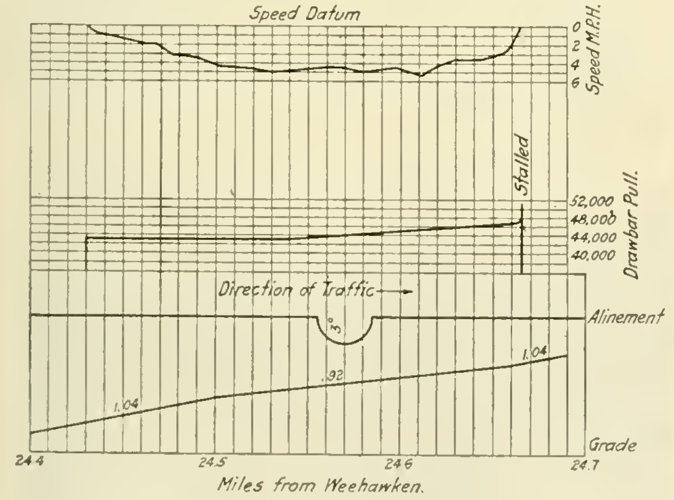


Fig. 5—Stalling Test to Determine Maximum Drawbar Pull With the Booster

is 1,800 tons to Newburgh, at which point it is increased to 2,100 tons to Kingston, where it is again increased to 2,600 tons to Ravena. Use of the booster permitted increasing the tonnage to 2,015 out of Weehawken, increasing it to 2,577 at Cornwall and again increasing it to 2,745 tons at Kingston, which tonnage was hauled to Ravena.

The ruling grade going west on this division begins 7⅓ miles from Weehawken at Bogota. It is a one per cent grade approximately 1¾ miles long. The dynamometer record was started at a point eight miles from Hohokus, where the speed was 25 m.p.h., and about two-thirds the way up the speed had dropped to 13 m.p.h. At this point the booster was cut in. As shown in Fig. 4 the drawbar pull immediately increased from 34,228 lb. to 38,793 lb., an increase of 4,565 lb.

At West Nyack a test was made to determine the combined power of the locomotive and the booster. The grade at this point is 1.04 per cent. The train was brought to a standstill and a start made by taking slack. As shown by the dynamometer car record (Fig. 5) the train proceeded .235 of a mile, where it stalled, and the maximum drawbar pull at zero speed registered 51,138 lb. The boiler pressure re-

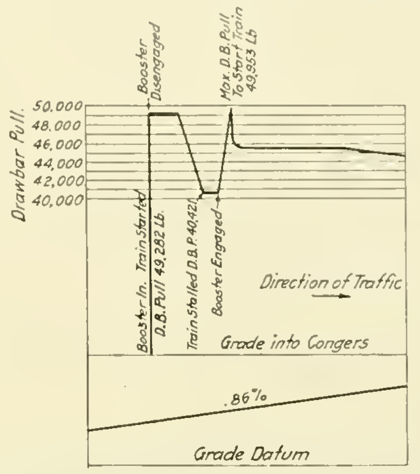
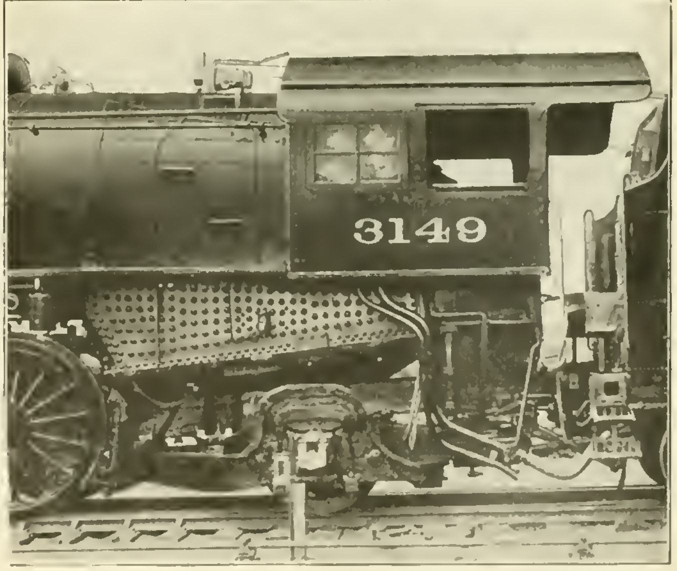


Fig. 6—Stalling Test to Determine Maximum Drawbar Pull Without the Booster

mained constant; the throttle was wide open and the reverse lever in the corner.

To determine the maximum drawbar pull of the locomotive without the booster a test was made on an 0.86 per cent grade into Congers, the tonnage at this point being 1,958 tons, one car having been set off on account of hot boxes. With the booster working, the train was brought entirely on the grade, the booster then cut out, and the engine proceeding until



A Close View of the Trailer Truck With the Booster

stalled. As shown by the dynamometer car record (Fig. 6) the drawbar pull registered 40,421 lb. at zero speed. To get the train moving again the booster was engaged and the maximum drawbar pull registered 49,953 lb., showing an increase of 9,532 lb., or the additional drawbar pull which the booster exerted.

At Cornwall the tonnage was increased to 2,577 tons, the

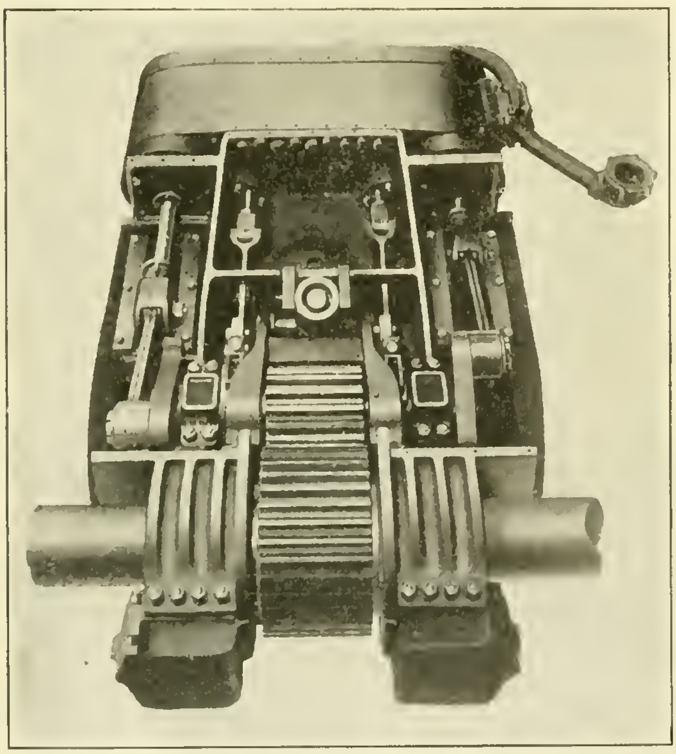
usual tonnage from this point to Newburgh being 1,800 tons. At West Park, on a .52 per cent grade, it was found necessary to use the booster again as the speed had dropped to 12 m.p.h. Upon arrival at Kingston the train was increased to 2,745 tons, which is 145 tons in excess of the regular rating of 2,600 tons, and the train continued to Ravena successfully handling this tonnage.

One of the important features of the booster emphasized by these tests was the rapid acceleration, which is accomplished at practically no increase in weight, as the booster weighs less than 4,000 lb. The following tabulation shows clearly the reason for this:

Maximum drawbar pull of locomotive	40,421 lb.
Drawbar pull of locomotive necessary to move train on given grade	36,441 lb.
Difference (force available for acceleration)	3,980 lb.
Maximum drawbar pull of locomotive with booster in operation	49,618 lb.
Less drawbar pull necessary to move train	36,441 lb.
Reserve for acceleration with booster is increased to	13,177 lb.
Deducting force available for acceleration without the booster	3,980 lb.
Increased force available for acceleration on the same locomotive with the booster operating	9,197 lb.

Hence 9,197/3,980 equals 231 per cent increase in force available for acceleration purposes.

On freight trains rapid acceleration is important, as it enables a quick get-away and the increase in available starting power means a smooth, even start.



Driving Mechanism of the Booster

Quick acceleration often saves sufficient time to permit a freight train to continue on its run when otherwise it might necessarily have to take a siding to permit other trains to pass. Moreover, the additional capacity which the booster contributes to the locomotive in starting avoids damage to rolling stock by avoiding the need of taking slack.

On passenger trains it means saving time in starting from station or other stops. A few minutes saved at each stop with a heavy train helps maintain operating schedules. The smooth, easy start also adds to the comfort of the traveling public.

Conclusions

From the results of these tests the following conclusions were drawn:

1. The booster makes possible increasing the tonnage that a locomotive can haul.
2. It provides quick acceleration that helps maintain schedules more easily and reduces the time over the division. In several instances under observation the time consumed in getting freight trains out of terminals and yards was reduced 50 per cent.
3. It eliminates the need for taking slack in starting.
4. It reduces tire and rail wear as slipping of drivers is avoided.
5. Because of its smooth, steady pull at starting it reduces wear and tear on equipment and eliminates breaks-in-two.
6. It increases the average speed over grades and eliminates stalling.
7. The booster power is always instantly available at speeds below 12 m.p.h.
8. It helps relieve traffic congestion, increasing the maximum ton-miles over the division.
9. No extra coal is consumed because of the booster, and fuel economy should result because the time required over the division is reduced.
10. The booster is automatic in operation and control and adds no extra duties to the engine crew.
11. It gives the effective increase in starting drawbar pull that an additional pair of drivers would give, but avoids hauling around 50,000 lb. or more weight that a larger locomotive would involve, weight that is useless a large percentage of the time and that present track and bridge structure will not carry.
12. The booster is in motion less than 10 per cent of the time. Its maintenance is negligible.
13. It avoids stalling where sudden weather changes while enroute would render impossible the hauling of normal tonnage.
14. It provides a reserve capacity that helps to even out the difference between an experienced and inexperienced crew.

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New York Harbor, Looking North Along West Street

Relative Merits of Steam and Electric Traction

Strong Points of Both Outlined at a Joint Meeting of Electrical and Mechanical Engineers

The advantages of steam and electric locomotives were discussed by their exponents at a joint meeting of the New York Section of the American Institute of Electrical Engineers, the Metropolitan Section of the Railroad Section of the American Society of Mechanical Engineers, held on October 22 in the Engineering Societies building, New York. One paper on steam locomotives and two papers on electric locomotives were presented and the papers were discussed by several railroad and railroad supply men.

The following are abstracts of these papers and the subsequent discussion:

ADVANTAGES OF ELECTRIC LOCOMOTIVES HAVE BEEN GREATLY OVERSTATED

BY JOHN E. MUHLFELD
Railway and Industrial Engineers, Inc.

In the protection and control of railroad net earnings, one of the most important factors is the kind of motive power to be used.

When discussing or recommending the further electrification of the whole or any part of the steam operated railroads in the United States, the most important item involved is a correct and complete statement of facts, comparing the most up-to-date steam with similar electric operations, after which immediately come the important factors of the necessary financing and legislation.

While there is much existing steam road trackage that can and should receive first consideration as regards electrification for the purpose of eliminating gases from underground terminals and tunnels and to give relief to terminal or line traffic congestion in the vicinity of large commercial and industrial centers, it would be financial suicide to electrify immediately adjacent connecting and intermediate mileage, particularly in view of the improvements that can be made in both existing and new steam locomotives in increasing general efficiency and economy in operation and maintenance.

Before the electric locomotive can be made permissible for general application the electrical engineer must reduce first costs; promote interchangeability; provide a motor which will efficiently, economically and flexibly cover a wide range of speeds and not break down or deteriorate from overloading and heating; reduce complication, wear and corrosion in transmission and contact line apparatus; and substantially reduce the current losses between the point of power production and the locomotive drawbar. Likewise the steam railway mechanical engineers, locomotive builders and specialty manufacturers, if they are to continue the steam locomotive in its present field of usefulness, must become more active in modernization and bring about improvements that will substantially increase its capacity and thermal efficiency by the use of higher steam pressures and superheat; compounding; more efficient methods of combustion; utilization of waste exhaust steam and products of combustion heat; better distribution and use of live steam; reduction of dynamic weights; greater percentage of adhesive to total weight and a lower factor of adhesion; and by a substantial reduction in standby losses.

In order to determine the relative advantages of modern steam and electric locomotives the following may be stated as important items for consideration:

Financing. Few if any existing steam roads can justify or stand the additional capital investment required per mile of road for electrification, except for short distances under very special conditions such as prevailed on the Norfolk & Western; where the ventilation and 1.5 per cent grade of ⅝ mile single track tunnel restricted the train movements to six miles per hour on a congested traffic section of the main line, and even then only providing the fixed charges and operating expenses are not too excessive.

Adaptability to Existing Trackage and Facilities. Foremost in favor of a continuation of the steam locomotive is its flexibility and adaptability to existing railroad trackage, terminal and operating facilities, and the relatively low first cost per unit of power developed for the movement of traffic. Being a self-contained mobile power plant, it is possible to quickly transfer needed or surplus power from one part of the line to another and to concentrate it when and where necessary, whereas with the electric locomotive this is impossible unless electrification extends over the entire property or the sources of power supply have almost prohibitive peak load capacity. Furthermore, the various systems of electrification do not make the interchanging of electric locomotives practicable without much non-productive first-cost, complication, and maintenance and operating expense.

Effectiveness in Increasing Track Capacity. Without a doubt electrification increases the capacity of a terminal. As already set forth, special line conditions may make electrification advisable for short distances, but results do not justify the frequent reference by electrical engineers to the weakness of steam locomotive haulage during the unprecedented cold weather in the winter of 1917-18. If electrification would have obviated the difficulty, why did the New Haven not operate at 100 per cent of its capacity, over its electrified zone at that time? If short of locomotives or motor cars the New York Central had plenty of surplus that was not in use and which could not be utilized outside of its electric zone where it was badly needed. The probable answer is lack of interchangeability, which is still one of the most discouraging operating factors involved in any electrification scheme. Although under the multiple unit system locomotive and train operation it is theoretically possible to provide unlimited sustained hauling capacity, at the head of the train, the tonnage to be handled without rear end or intermediate helpers is limited by the ability of the draft rigging on the cars to withstand the pull and shock, and this limitation can be readily met and exceeded in steam locomotive design and operation.

Train Speeds. The average freight car is in main line movement only about 10 per cent of its life, or 2 hr. and 24 min. out of each 24 hr. Therefore, increasing train speeds beyond established economic limits at the sacrifice of tonnage, and with an increase in fuel, track and equipment upkeep and danger of operation is not the solution of the freight traffic problem.

As the electric locomotive is a constant speed machine, whether going up or down grade, and is unable to utilize its rated capacity and effectiveness through the same range of speed and tractive power variations as the more flexible steam locomotive, the latter can therefore be more efficiently operated over the continually changing up and down grades, levels, curves and tangents traversed by the average freight train in this country. With respect to passenger train service, where speed is more of a factor, the steam locomotive performs equally satisfactorily.

Fuel Consumption. Great economy in fuel consumption and cost is the principal claim for electrification and recently electrical engineers have advanced the theory that it

would be possible to save at least two-thirds of the coal consumed by the existing steam locomotives and that the useful carrying capacity of existing trackage could be increased about 10 per cent by the elimination of company coal movement, if electric locomotives were substituted.

The basis for arriving at these comparative figures is so obviously ridiculous that they warrant comment only for the reason of the general publicity given.

However, accepting the assertion that the proposed electrification will produce 1,000 gross ton-miles for an average of 40 kilowatt hours, or 100 lb. of 12,000 B. t. u. coal, as stated and generally approved by electrical engineers, what can the modern steam locomotive do to justify its existence? The following results of dynamometer car tests made during 1918, may be of interest. The steam locomotives tested were of the ordinary superheated Mikado freight type. One locomotive was fitted for hand firing and burning coal on grates while another was equipped for burning powdered coal in suspension. The tests were made in tonnage freight service on the Santa Fe main line between Ft. Madison, Iowa, and Marceline, Mo. (the profile consisting of .8 per cent ruling grades), a distance of 112.7 miles; during March and April, 1918.

Item	Powdered coal locomotive	Hand fired locomotive
1—Total trips run (112.7 miles each)	14	10
2—Total miles run	1,578	1,127
3—Average running time (hours)	5.06	5.25
4—Average dead time (hours)	1.25	1.01
5—Average total time (hours)	6.31	6.26
6—Average speed (m. p. h.)	22.3	21.6
7—Average trailing tonnage per train	2,278	2,283
8—Average gross 1,000 ton miles	256.5	255.4
9—Average coal per gross 1,000 ton miles	82.4	114.8
10—Average B.t.u. per pound of coal as fired	12,025	11,160

It can be assumed from the foregoing that the average yearly performance will approximate 100 lb. of 12,000 B. t. u. coal per 1,000 gross ton-miles, or equivalent to what we are promised for the expenditure of billions of dollars of new capital and the loss of billions of dollars' worth of investment in existing plant and equipment to inaugurate the comforts of electrification.

It is also not out of order to refer to dynamometer car tests which it is understood have been made on the New York Central, wherein on the basis of the thermal value of the coal, a single expansion superheated steam locomotive required, per drawbar horsepower hour, about 2.6 lb. of coal as compared with about 2.25 lb. for an electric locomotive.

Efficiency of Locomotive Operation. The off-setting fuel and energy losses, due to standby losses in the steam operation, and decrease in efficiency on account of fluctuating loads in the electric operation must not be lost sight of. Neither should those incident to the transforming, transmission and conversion of electric current and like factors be neglected.

It is unquestionably true that when operating under ideal fixed load conditions, the central power station, either hydro-electric or steam, can produce a horsepower with less initial energy input than is possible on a steam locomotive. It is also true that the standby losses on existing steam locomotives are, in ordinary practice, a serious proportion of the total fuel consumption, but it is likewise a fact that the majority of these can be substantially reduced if not entirely overcome, by modernizing the present equipment and improving maintenance and operation which would then rob the electrical engineers of their main argument in favor of a blanket electrification.

While the electrical engineers and manufacturers in this country deserve great credit for the progress made in the development of the electric locomotive, they have as yet been unable to design one which can operate at maximum efficiency throughout its range of load. The point of maximum efficiency being well established and fixed, and the current curve on an electric motor not being flat, any over or under-load from the predetermined maximum efficiency load increased the current consumption. Furthermore, when, on account of transportation conditions, a motor is required to carry an overload for periods of five or six hours, it either breaks down due to heating or otherwise requires special power consuming auxiliaries or long rest periods for the dissipation of the heat stored within itself due to the resistance of the current through the wiring, to permit of continuous operation.

The number of factors entering into an analysis of the net thermal efficiency of the electric locomotive, in terms of drawbar pull, are so many as to make it impossible, with the lack of dynamometer car and laboratory test data, to arrive at a figure which is not based on a number of assumptions; but as a matter of interest, assuming, that *all of the factors are affected equally* in the electric locomotive, the net thermal efficiency at the drawbar, when taking into consideration the boiler, engine, generator, step-up transformer, a. c. transmission, step-down transformer, a.c.-d.c. converter, d.c. transmission, motors, and machine efficiencies may, as representative of average existing practice, be taken as shown in Table 1.

TABLE 1—COMPARATIVE EFFICIENCIES OF ELECTRIC AND STEAM LOCOMOTIVES

ELECTRIC EQUIPMENT

	Efficiency factors and net thermal efficiency, per cent.	Load rating, per cent 100	75	50
Boiler	Factor	.....	.....	.....
	Efficiency	76.7	76	72
Engine	Factor	18.25	18.29	19.17
	Efficiency	14	13.9	13.8
Generator	Factor	90	89.5	86
	Efficiency	12.6	12.44	11.88
Transformer, Step-Up	Factor	98	96	90
	Efficiency	12.34	11.93	10.67
Transmission, A.C.	Factor	90	95	97
	Efficiency	11.10	11.32	10.34
Transformer, Step-Down	Factor	98	96	90
	Efficiency	10.87	10.85	9.30
Converter, A.C. to D.C.	Factor	80	75	63
	Efficiency	8.69	8.13	3.85
Distribution, D.C.	Factor	90	95	97
	Efficiency	7.82	7.71	5.66
Motors, D.C.	Factor	91.5	90.8	89.5
	Efficiency	7.15	7.00	5.05
Machine Efficiency	Factor	81	85	90
	Efficiency	5.79	5.95	4.54

STEAM LOCOMOTIVE

Equipment	Superheated or saturated	Efficiency factors and net thermal efficiency, per cent.	Load rating per cent 100	75	50
Boiler	Superheated	Factor	.....	.....	.....
		Efficiency	42.7	54.9	65.9
	Saturated	Factor	.....	.....	.....
		Efficiency	45.0	57.4	70.0
Cylinders	Superheated	Factor	11.9	11.0	10.5
		Efficiency	5.08	6.04	6.92
	Saturated	Factor	7.8	8.4	7.8
		Efficiency	3.51	4.82	5.46
Machine	Superheated	Factor	75	80	85
		Efficiency	3.85	4.83	5.88
	Saturated	Factor	77	80	82
		Efficiency	2.70	3.86	4.47

Comparing the electric and steam locomotive figures as illustrated, the relative percentage of power delivered at the track rails to 100 per cent B. t. u. in the coal would be:

Kind of locomotive	Net thermal efficiency at load ratings of 100 per cent	75 per cent	50 per cent
Electric	5.79	5.95	4.54
Steam, superheated	3.85	4.83	5.88
Steam, saturated	2.70	3.86	4.47

As 100 per cent load rating conditions would, in practice, occur only momentarily and as the majority of the drawbar load represents from 30 to 60 per cent of the locomotive maximum drawbar capacity, comparison should properly be made only of the net thermal efficiencies at 50 per cent load ratings.

Various dynamometer car and laboratory test performances of representative types of steam passenger and freight locomotives confirm the foregoing figures relating to steam operation. At speeds of from 15 to 75 miles per hour the existing superheated steam locomotive thermal efficiency actually ranges from 5.3 to 8.1 per cent as compared with the calculated figures of from 4.83 and 5.88 per cent for 75 and 50

per cent load ratings, respectively. Adding to this an increase of from 15 to 50 per cent in net thermal efficiency that may be produced from developments now under way, the steam locomotive of the future will be quite a respectable assembly of engineering efficiency.

Cost of Maintenance. In determining the maintenance cost of the electric locomotive the popular error is to take into account the locomotive proper, whereas a true comparison can only be made by including all corresponding elements as found in the self-contained steam locomotive which goes back to the upkeep of all facilities having to do with the utilization of the fuel or water-power, including the central power station buildings; boilers; engines; conversion, transmission, distributing and contact line systems; sub-stations; track rail bonding and insulation; electric disturbance cut-outs or neutralizers; extra expense in upkeep of the electric zone trackage; and like auxiliaries and finally the electric locomotive itself.

Peak Load Conditions in Relation to Traffic Requirements. With the steam locomotive the traffic requirements are met by the distribution and utilization of the necessary number of self-contained motive power units as required, regardless as to the capacity of one or more central power stations or of any limitation in quantity, or in price, of the total available power output. The operation of one or of 500 steam locomotives at their maximum capacity at any given moment, or for any duration of time on a single division, is of no concern.

However, in order to meet the ideal conditions for electrification, the traffic should be uniformly spread or scattered over the 24 hr. period, whereas in the majority of cases train movement is based on traveling and shipping conditions and cannot be advanced or delayed in order to eliminate peak load conditions.

Rate of Acceleration. In order that the desired running speeds can be reached in the minimum of time after the starting of trains, the ability of a locomotive to accelerate its load rapidly is of considerable importance and in this respect the electric power has had the advantage. The steam locomotive engineer has, however, not lost sight of this fact and improvements already made in boiler and cylinder horsepower ratios, as well as developments now undergoing for the utilization of existing non-productive adhesive weight and to increase the coefficient of friction between the propelling wheels and the track rails, will enable the steam locomotive to duplicate the performance of its electric competitor in this regard.

Train Braking. Since the development of regenerative braking with the electric locomotive, great emphasis has been laid on the increased security of operation over heavy grade lines due to the ability of the locomotive to hold the train under complete and positive control on the down grade without brakes, by temporarily converting the main motors into generators to produce electricity which is returned to the line for use by some other locomotive in pulling a train. Considerable attention has also been directed to the saving brought about through the elimination of the ordinary air braking on such down grades.

While the regenerative system of braking can no doubt be developed to the point where it can be safely used, in view of the recent serious accident on the St. Paul, due to the failure of the regenerative brake control, just what economy will result is problematical. When the power so generated cannot be directly used by another pulling locomotive on the line, it must be otherwise absorbed, and it remains for the electrical engineers to prove just how much of it is lost in conversion or by absorption and the resulting net gain as compared with the investment, fixed charge and upkeep and operating cost for the equipment involved.

Effect of Weather Condition. Even though the full steaming capacity, horsepower and drawbar pull of a modern steam locomotive can be developed during cold weather conditions, there are the factors of radiation and freezing to be reckoned with, which give the electric locomotive the advantage in winter, particularly, as its effectiveness is greater on account of the lesser tendency for the motors to overheat. This winter advantage, however, is largely overbalanced during the summer when the main motors heat, especially under overloads, and require cooling at terminals or otherwise overheat and result in insulation break-downs or burnouts, or other troubles.

Road Delays and Tie-Up. While the electric locomotive has the advantage of not being required to take on fuel and water, except for the operation of steam heating equipment for passenger trains, with the increased capacity of the modern steam locomotive tenders, and the lower water and fuel rates per drawbar horsepower developed, the delays due to taking on these supplies have been greatly reduced and need not be serious.

Barring collisions, wrecks and like accidents not due to the system of motive power in use, steam operation is not susceptible to complete tie-ups as is the case with electrification, where short circuits or failures occur due to rains, floods, storms and like causes, and as the result of motor, wiring and insulation heating, deterioration and break-downs, as the individual mobility of each piece of motive power without regard to any outside source of power enables quick relief.

Terminal Delays. The examination of reports of a dense heavy freight traffic railroad in the Eastern District shows the time of its steam locomotives for a recent two months' period distributed as follows:

1—In road service	50 per cent of total time
2—At terminals waiting trains and otherwise in hands of Transportation Department	26.4 per cent of total time
3—At terminals in hands of Mechanical Department	23.6 per cent of total time

There is no doubt that the electric locomotive has an advantage over the steam locomotive as regards time required for periodical boiler work, cleaning and rebuilding fires, fueling and watering except where fuel oil is used, but where terminal delays occur due to waiting for trains, such as the foregoing statement set forth, the time required for such work does not become an expensive determining factor in the daily average miles to be obtained per locomotive.

Hazards. With the establishing of more scientific and careful methods of designing, testing and inspection, and the more extended use of safety appliances, the failures of steam locomotive boilers and machinery, particularly those resulting in personal injury, are relatively low as compared with the work performed. It is, therefore, doubtful if there is any greater proportion of risk from the steam locomotive in that regard than from electrocution and other attendant dangers from high voltage electrification.

FOURTEEN POINTS FOR ELECTRIFICATION

BY A. H. ARMSTRONG
Chairman, Electrification Committee, General Electric Company

A comparison of the modern steam and electric locomotive leads immediately to a discussion of the relative fitness of the two types of motive power to meet service conditions. Place at the disposal of an experienced train despatcher a locomotive capable of hauling any train weight that modern or improved draft gear can stand, at any speed permitted by track alinement regardless of ruling grade or climatic conditions, that can be run continuously for a thousand miles with no attention but that of the several operating crews, and witness what he can accomplish in his all-important task of expediting freight movement. It is not merely a question of replacing a Mikado or Mallet by an electric locomotive of equal capacity. The economies thus effected are in many instances not sufficient

in themselves to justify a material increase in capital account. The paramount need of our railways today is improved service and this can be brought about by introducing the more powerful, flexible and efficient electric locomotive. While a maximum standing load of 60,000 lbs. per axle has been generally accepted for steam engines, it is well known that an impact of at least 30 per cent in excess of this figure is delivered to rail and bridges due to unbalanced forces at speed. Impact tests taken on electric locomotives of proper design disclose the feasibility of adopting a materially higher limiting weight per axle than 60,000 lb., without exceeding the destructive effect on track and road bed now experienced with steam engines.

Accepting the Mikado and Mallet as the highest developments of steam road and helper engines for freight service, the following general comparison is drawn with an electric locomotive that it is entirely practicable to build without in any respect going beyond the experience embodied in locomotives now operating successfully.

Comparison on Steam and Electric Locomotives

	Mikado	Mallet	Electric
Type	2-8-2	2-8-8-2	6-8-8-6
Weight per driving axle	60,000 lb.	60,000 lb.	60,000 lb.
Number driving axles	4	8	12
Total weight on drivers	240,000 lb.	480,000 lb.	720,000 lb.
Total weight loco. and tender	480,000 lb.	800,000 lb.	780,000 lb.
Trac. eff. at 18 per cent coef.	43,200 lb.	86,400 lb.	129,600 lb.
Gross tons 2 per cent grade	940	1,880	2,820
Trailing tons 2 per cent grade	693	1,495	2,430
Speed on 2 per cent grade	14 m.p.h.	9 m.p.h.	16 m.p.h
H.P. at driver rims	1,620	2,080	5,570
I. H. P. at 80 per cent eff.	2,030	2,600	....
Trailing ton miles per hour on 2 per cent gradient	9,700	13,500	38,800

In view of the facts, it is a modest claim to make, therefore, that the daily tonnage capacity of single track mountain grade divisions will be increased fully 50 per cent over possible steam engine performance by the adoption of the electric locomotive.

Aside from the power returned by means of regenerative braking (14 per cent of the total on the Chicago, Milwaukee and St. Paul Railway) the chief advantage of electric braking lies in its assurance of greater safety and higher speeds permitted on down grades. The heat now wasted in raising brake shoes and wheel rims often to a red heat is returned to the trolley system and becomes an asset instead of a likely cause of derailment.

Cost of Maintenance

Probably in no one respect does the electric locomotive show greater advantage over the steam engine than in cost of maintenance. Electric locomotives are now being operated 3,000 miles between inspections on at least two electrified railways and the following figures are available.

Electric Locomotive Maintenance, Year 1919

	N. Y. C.	C..M.& St. P	B. A. & P.
Number locomotives owned	73	45	28
Locomotive weight, tons	118	290	84
Annual mileage	1,946,879	2,321,148	566,977
Repairs per mile	6.39 cents	14.65 cents	6.48 cents

In contrast, it can be stated that the present cost of maintaining a type 2-8-8-2 Mallet is fully 60 cents per engine mile, without including many miscellaneous charges not shared by the electric locomotive.

Possibly more direct comparison may be better drawn by expressing maintenance in terms of driver weight.

Steam and Electric Repairs

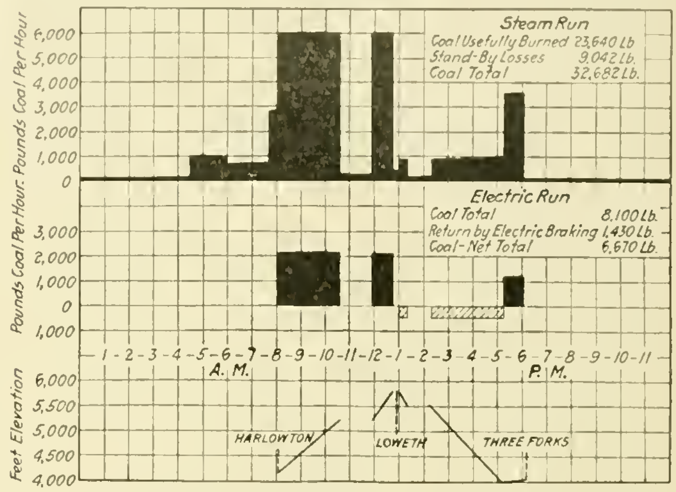
	Steam Mallet	C. M. & St. P. Electric
Cost repairs per mile	60 cents	14.65 cents
Weight on drivers	240 tons	225 tons
Cost, repairs per 100 tons loco. wt. on drivers	25 cents	6.52 cents

Including all engine service charges, the facts available give foundation for the claim that electric locomotives of the largest type can be maintained for 25 to 30 per cent of the upkeep cost of steam engines operating in similar service.

Fuel Saving

Fuel economy figured prominently among the several reasons leading up to the replacement of the steam engine on the Chicago, Milwaukee and St. Paul Railway as brought out by a careful analysis of the performance of the steam engines then in service.

The data indicated on the curves illustrated is therefore submitted as applying to a particular equipment only. No claim is made that it is representative of the best modern



Coal Record on a Basis of 1000 Gross Tons Moved for Steam and Electric Runs from Harlowton to Three Forks, Mont.

steam engine performance, although many thousands of steam engines still in operation will show no greater economies than those given in the following table:

C. M. & St P Tests—Locomotive Data

	Steam	Electric
Type	2-6-2	4-4-4-4-4-4
Weight of engine	206,000 lb.	568,000 lb.
Weight of tender	154,000 lb.	....
Weight total engine and tender	360,000 lb.	568,000 lb.
Weight on drivers	152,000 lb.	450,000 lb.
Ratio driver weight to total	42.2 per cent	79.3 per cent
Rigid wheel base	13 ft.	10 ft. 6 in.
Diameter drivers	63 in.	52 in.
Cylinders	21 in. x 28 in.	....
Boiler pressure	200 lb.	....
Heating surface	2,346 sq. ft	....
Grate area	45 sq. ft.	....
Water capacity	8,000 gals	....
Coal capacity	14 tons	

The run of 111.1 miles from Harlowton, elevation 4,162 ft., to Three Forks, elevation 4,066 ft., over the Belt Mountain Divide at Loweth, elevation 5,789 ft., was made by steam with 871 ton trailing in 26 cars and by electric locomotive hauling 64 cars weighing 2,762 tons. The fuel furnishing power to the steam train was coal having the following analysis:

Coal Analysis

Fixed carbon	Volatile carbon	Ash	Moisture	B.t.u's
47.99	38.98	8.35	4.68	11,793

Electric power was furnished by water and hence no direct coal equivalent is provided by the test result. To afford a common basis of comparison, however, a single assumption seems permissible and a rate of 2½ lb. of coal per kilowatt hour is taken as representative of fair electric power station practice. Coal burned under the steam engine boiler was determined by weighing at the end of the run and by detailed record of scoops en route. Power input to the electric locomotive was obtained by carefully calibrated recording watt meters as well as curve drawing volt and ampere meters.

Pounds coal per gross 1,000 ton miles may vary on steam locomotives from 650 to 50.5 according to gradient and with no standby losses whatever included. The boiler must be kept hot at all times, however, and fully 33 per cent can

safely be added to include the inevitable standby losses inherent to steam engine operation. Except over very long runs with terminals at the same elevation it seems hardly possible therefore to accurately compare engine performance over different profiles by such a variable unit as pounds coal per 1,000 ton mile.

However efficient the power plant on wheels may reasonably be developed without too seriously interfering with the sole purpose of the steam engine, the hauling of trains, it can never approach the fuel economics of modern turbine generating stations. Whatever transmission and conversion losses are interposed between power house and electric locomotive are more than compensated for by the improvement in the load factor resulting from averaging the very fluctuating demands of many individual locomotives.

Theoretical Comparison Modern Steam and Electrical Locomotives Harlowtown Three Forks

	Mikado	Electric
Type	2-8-2	4-4-4-4-4-4
Wt. on drivers	240,000 lb.	450,000 lb.
Wt. engine and tender	480,000 lb.	568,000 lb.
Trac. eff., 18 per cent coef	43,200 lb.	81,000 lb.
Trailing ton, 1 per cent grade	1,420	2,836
Hp. hr. at driver rims	4,360	8,200
Coal per ind. hp. hr	3	
Coal per driver hp. hr	3.75	
Standby loss—test result	9,042 lb.	
Standby loss per hp. hr	2.15 lb.	
Total coal per driver hp. hr	5.90 lb.	
Coal at power house, kw. hr		2.5 lb.
Coal at power house, hp. hr		1.86 lb.
Coal at loco. driver, hp. hr		3.09 lb.
Coal credit due regeneration		.55 lb.
Net coal at driver hp. hr	5.90 lb.	2.54 lb.
Total net coal	24,800 lb.	20,900 lb.
1,000 trailing ton miles	157,500	314,000
Coal per 1,000 ton miles	158 lb.	66.7 lb.
Ratio coal burned	2.37	1

The above table is based upon actual electric locomotive performance, Harlowton-Three Forks, coal taken at 2½ lb. per kilowatt hour at assumed steam power station. Steam engine values are based upon the known working efficiency of a Mikado equipped with superheaters but penalized with the same standby losses actually determined by test. A test run from Harlowton to Three Forks with a modern Mikado engine hauling 1,420 tons may possibly show a lower average fuel rate than 3 lb. per I. H. P. Hr. at drivers, less standby waste than 9,042 lb. coal, but the average annual performance of many such engines would be most excellent if it reached the net figure arrived at of 5.9 lb. coal per actual H. P. Hr. work performed at drivers. The electric run, however, is being duplicated daily, as to relation between Kw. Hrs. and ton miles and it is just this reliability of electric operation that may at times give rise to misunderstanding in the comparison of steam and electric data.

Comparative Cost

Comparing the cost of equivalent steam and electric motive power, it is apparent that on the basis of the same unit prices for labor and material, the first cost is approximately the same. While electric locomotives cost possibly 50 per cent more than steam for equal driver weight, the smaller number required to haul equal tonnage may quite offset this handicap, especially with quantity production of electric locomotives of standard design.

The steam engine also demands a formidable array of facilities peculiar to itself. This expense covers fuel and water stations, shops and engine houses, shop machinery, turn tables, ash pits, etc. The task of proving the electric case is not made easier by the fact that steam engine facilities are already installed and may have little or no salvage value to offset new capital charge for electrification.

Summary

Some of the principal advantages claimed for the electric as compared to the steam locomotive may be briefly stated as follows:

1—No structural limits restricting tractive effort and speed of electric locomotive than can be handled by one operator.

2—Practical elimination of ruling grades by reason of the enormously powerful electric locomotives available.

3—Reduction of down grade dangers by using regenerative electric braking.

4—Very large reduction in cost of locomotive maintenance.

5—Very large saving of fuel, estimated as two-thirds the total now burned on steam engines in operation.

6—Conservation of our natural resources by utilizing water power where available.

7—Material reduction in engine and train crew expense by reason of higher speeds and greater hauling capacity.

8—Increased valuation of terminal real estate following electrification.

9—Increased reliability of operation.

10—Material reduction in operating expense due to elimination of steam engine tenders and most of the company coal movement, the two together expressed in ton miles approximately nearly 20 per cent of present gross revenue ton mileage.

11—Large reduction in effect of climatic conditions upon train operation.

12—Postponement of immediate necessity for constructing additional tracks on congested divisions.

13—Attractive return on cost of electrification by reason of direct and indirect operating savings effected.

14—Far reaching improvements in operation that may revolutionize present methods of steam railroading.

ELECTRIC MOTIVE POWER FOR TRAFFIC DEMANDS OF TOMORROW

BY F. H. SHEPARD

Director of Heavy Traction, Westinghouse Electric & Manufacturing Co.

With the present standards of train make-up, classification and terminal handling, electrification will double the capacity of any railroad. With the better equipment we can expect in the future, together with the evolution of improved methods of operation contingent on electric power, this capacity should be doubled again, thus securing four times the present capacity. This should certainly be accepted as a vision of the future, and why not our aim? Unless some broad and consistent program is embraced, the situation, which is serious indeed today, may well be calamitous tomorrow. The electric locomotive has generally, thus far, been a mere substitute for the steam locomotive, although, in some cases, due to the greater power of the electric locomotives, there has been a modification of the handling of traffic.

Two conspicuous cases of this have been the Norfolk & Western and the Chicago, Milwaukee & St. Paul. In the case of the Norfolk & Western, two electrics handle the same train as was formerly handled by three Mallet engines, but at twice the speed. In this operation, owing to the great increase in hours of road service as well, one electric locomotive is the practical equivalent of four of the Mallet engines replaced.

On the Chicago, Milwaukee & St. Paul, the notable change has been the elimination of intermediate terminals on the electrified section between Harlowton, Montana, and Avery, Idaho, 440 miles long. There is at present a single intermediate engine terminal, but the latest passenger locomotives are detached from trains at this terminal for inspection and work only, which takes place about once in each eight or ten trips. On regular schedule, these engines make a run of 440 miles each day, being taken off for inspection at Deer Lodge after mileage varying from three to five thousand miles. On occasion, when, due to a schedule derangement, engines have been maintained in continuous road service for periods of thirty hours or more, for a full day of twenty-four hours,

mileage records of up to 766 miles in this mountain service have been established. These records are truly indicative of what may be expected with electric power.

With the retirement of the lighter and weaker car equipments, a material increase in the weight of trains will be realized. Without the limitation in train speed commonly accepted as a handicap to operation of tonnage trains, who can say what the limit to train load will be with electric power? In fact, the character of railroad operation which may be secured with electric power has not yet been visualized. Every other industry that has been electrified has experienced a revolution in methods and service due to electrification. This should be equally true in the case of the movement of our railroad traffic.

Car inspection now takes place at the terminus of each engine district. If, under condition of electric operation, the engine district can be increased to 200, 400 or even 500 miles, is there any good reason why car inspection should not be eliminated at the present intermediate terminals? In fact, is not the general standard of maintenance of equipment of doubtful value on the present basis of inspection at each 100 mile interval? Cars in subway service, which is certainly full of potential hazard, are economically and reliably maintained through inspection at intervals of one or three thousand miles. The elimination of these intermediate terminals, with the resultant necessity of keeping the train moving on the main line, would secure an enormous increase in miles per car with a corresponding saving in equipment.

The generation of power in central stations is surrounded with many refinements, and in the consumption of coal, there is every opportunity for skillful handling and supervision, so that the thermal efficiency of a modern central station is relatively high and is also continuously maintained. With the steam locomotive, on the other hand, the thermal efficiency is dependent not alone upon the design of the locomotive, but the manner in which it is worked, its condition, which differs widely from the best, and finally by the skill in firing. The electric locomotive, on the other hand, consumes power only when in service, and works at any load at its designed efficiency. The average performance, in the case of the electric locomotive approximates the maximum in efficiency, while the steam locomotive, on average performance, will differ widely therefrom.

We can therefore expect that with the best steam locomotives the average coal consumption will be equal to twice the coal rate for the same work performed by electric locomotives with steam generated power. Obviously, with hydro-electric generation, the saving in fuel is complete. There is further economy due to the lesser work performed, because the electric locomotive does not have to trail supplies of fuel and water, nor is there need for the hauling of coal to points of local supply, which will always be greater than hauling to electric central stations.

There are a considerable number of different designs of electric locomotives all in successful operation, and each possessing certain advantageous features. Further experience will, undoubtedly, result in the survival of common types for the different classes of service. The great latitude with which electric locomotives can be designed, while fundamentally most desirable, is in itself at the present time somewhat of a handicap. This is now the subject of intensive analysis and this study is undoubtedly developing, as well, a better knowledge of the running characteristics of the steam locomotive.

To state the case briefly, we are all interested in the transportation problem. Electrification is bound to be the most potent factor for its relief. We should therefore invite and embrace closest co-operation with the engineering and mechanical skill which has been so productive in the steam locomotive field.

Discussion

The discussion of the principal papers took the form of reading prepared discussions some of which are outlined as follows:

H. B. Oatley, chief engineer, Locomotive Superheater Company, stated that while both electric and steam locomotives were undoubtedly able to stand on their own merits, that it was futile to discuss these merits without some idea of what the return on the capital investment will be, in view of the difficulties encountered by the railroads in obtaining capital. Modern electric locomotives must be compared with modern steam locomotives, the stand-by fuel losses of steam locomotives should be compared with similar losses in the power plant, losses inherent to the transmission and transformation of electric power.

F. J. Cole, chief consulting engineer, American Locomotive Company, stated that in the 27 years since the building of the first electric locomotive for operation of the tunnel into Baltimore, only about one per cent of the steam locomotives in this country have been superseded by electrics. Advocates of electric traction fail to produce complete financial statements of installations made and many ill-considered electric suburban lines have been abandoned. Electrically operated roads must have a large excess of power station capacity. A steam locomotive is a more flexible unit than an electric locomotive and a steam-operated road is not subject to tie-ups due to burned out cables, blow-outs, etc. Much of the fuel economy claims made for electric operation are based on unwarranted assumptions.

Facts Relating to Regenerative Braking, Fuel Economy and Maintenance

C. H. Quinn, chief electrical engineer (N. & W.) said that if we are to maintain our standing in the commercial world, our railroad facilities must go forward and keep pace with the commercial development of the nation and that for this reason effort should be concentrated on the development of freight locomotives which can meet coming requirements. Freight car capacities, he showed, have increased 100 per cent during the past ten years, while steam locomotive capacities have increased only 10 per cent. By comparing fuel consumption of the electrified division of the Norfolk & Western with tests made on modernized Mallet engines under similar operating conditions, Mr. Quinn showed a fuel saving of 29.3 per cent in favor of electric operation. In answer to a query on regenerative braking, it was pointed out that during the past five years twenty thousand 3,250-ton trains have been taken down a 2.3 per cent grade, using only regenerative braking, without a single failure.

A. L. Ralston, mechanical superintendent (N. Y., N. H. & H.) compared the thermal efficiency of the 3,000-volt direct current system with the efficiency of the electric locomotive as given in Mr. Muhlfeld's paper. It is stated that on the New Haven, the efficiency at full load was 8 per cent; at 75 per cent load, 7.8 per cent; and at 50 per cent, 7.4 per cent. To prove greater reliability of electric service, he cited the fact that there was only one failure for every 21,000 miles run by electric locomotives and a failure for every 4,000 miles run by steam locomotives. He stated that the records of the New Haven showed that in slow freight service, approximately 25 kw. hours were consumed per 1,000 gross ton miles in freight service. The coal per kw. hour averaged 2.92 lb. and the line loss was 7.1 per cent. The fuel consumption in passenger service was 9.3 lb. per car mile on the electric division while the average for steam operation on the New Haven was 19.3 lb. per car mile. With coal costing $5.00 a ton, the net saving through electrification was $393,000 a year.

In freight service, electric locomotives consumed 84 lb. of coal per 1,000 gross ton miles while steam locomotives aver-

aged 199 lb., the saving in this service being $268,000. In switching service, the consumption of electric locomotives was 38.3 lb. per mile and for steam operation, 106.8 lb. per mile, a saving of $94,000. The electrification was therefore responsible for a gross saving in the cost of fuel amounting to $755,000 annually.

The opinion was expressed by W. F. Kiesel, Jr., mechanical engineer of the Pennsylvania, that electric operation does not save coal and he produced figures obtained from locomotive tests to substantiate his opinion.

F. H. Hardin, chief engineer of motive power (N. Y. C.) stated that electric locomotives require back shop facilities as well as steam locomotives. Figures shown on the maintenance costs of New York Central Mallet locomotives, including shop and engine-house repairs, were from 24 to 37 cents per mile as against the estimate of 60 cents offered by Mr. Armstrong, and Mikado locomotives on the N. Y. C. show a fuel consumption of 125 to 130 lb. of coal per 1,000 gross ton-miles as against the estimate made by Mr. Armstrong of 158.

Broad Features Outlined

W. L. Bean, assistant general mechanical superintendent, while speaking for the steam men, presented an unbiased discussion based largely on his own experience. The following is an abstract of his remarks:

The prime factor to be considered in any engineering enterprise of commercial nature is the economic result of the entire specific project. Results of sub-projects in themselves are important and consideration sometimes of a multitude of factors of minor or more than minor nature must be sufficient, even to the last detail, but partisanship in championing some of the sub-factors to the exclusion of others is undesirable and of course does not represent the best of engineering procedure.

It must be conceded broadly that electrical operation requires less coal per unit of traffic handled than steam operation. How much less depends on the specific conditions. Likewise, the mileage per unit of electric equipment is ordinarily greater per unit of time. On one largely electrified road, express locomotives average 27 per cent more miles per day per locomotive owned than steam power in similar service. However, the first cost of the electric engines per unit of capacity was 84 per cent greater than in the case of steam. Therefore, the fixed charges are greater for the electric engine per unit of service.

A few words respecting comparative flexibility, especially in service of a character which demands it, may be of interest. A certain modern passenger electric locomotive will handle a heavy train of Pullmans at high speed on a through run with few stops such as would require a modern Pacific type steam engine of about 43,000 lb. tractive effort. However, to operate the electric engine in heavy local service over the same distance is impossible because of the heating caused by frequent starting. In such service, the maximum train which can be handled by the electric locomotive can only approximate what can be handled by a steam engine of about 30,000 pounds tractive effort.

Realization of the extent of accumulation of wear and tear, both electrically and mechanically, makes it difficult to understand just how railroads are to maintain electric locomotives without back shops unless they job the work out to manufacturers of electrical equipment.

Regarding the design of the machinery of a steam locomotive being utterly circumscribed by the necessity for tying it up to a steam boiler, the statement can be made that some modern high powered electric locomotives are so compact with apparatus, both inside the cabs and beneath, as well as on top, that additions to or enlargements of details, even of a minor nature, are well nigh impossible. Furthermore, this is not peculiar to AC-DC machines.

When one comes to attempting the solution of the problems attendant on the heating of passenger trains, electrically drawn; to find room for the boiler, water and fuel oil storage auxiliaries, etc., and keep within weight limitations, the difficulties are very real and certainly lead one to the conclusion that on electric passenger power the boiler is circumscribed by electrical apparatus.

It appears that when a railroad goes in for electrification, it must settle on some type of lay-out, the main characteristics of which are fixed. Extension must either be along the original plan as to power characteristics, distribution or collector apparatus, or else vast sums must be spent to re-vamp the existing plant if the new lay-out is not to be largely separate and independent with all of the inherent disadvantages of non-interchangeability and lack of flexibility.

The steam locomotive, except in a moderate way as to clearances and weight limits, has a wide range of application. Railroads loan steam power back and forth with advantage usually to both parties, but no case comes to mind where electrical equipment for heavy traction can be interchanged.

The design and operating characteristics of steam power have developed far more along lines of possible common usage and practice. It is to be hoped that the lines of development of electrical facilities will tend to converge rather than diverge too widely.

Tangibles from a money standpoint can and should be segregated and set up in full scope on both sides of the case and conclusions based on the net result at the bottom line of the balance sheet. If fixed charges on plant, including equipment, plus maintenance charges, plus other out-go, outweigh the savings in fuel, plus other operating savings, the net result is a deficit and all manner of proclaiming isolated pecuniary advantages would not induce a careful investor to support the enterprise.

Discussion by A. W. Gibbs

After reading the papers on steam versus electric operation of railroads, I cannot but feel that both Messrs. Muhlfeld and Armstrong have been a bit too enthusiastic. Both methods of operating have their advantages and both have decided limitations.

In Mr. Armstrong's case his data is largely derived from mountain electrification, where the electric locomotive is undoubtedly at its best and the steam at its worst, and he has compared with it a type of steam locomotive whose coal and water rate is more than double that of locomotives which are especially designed for such service. Then on this mountain performance he reasons from the particular to the general application of electric operation. True, he puts in a disclaimer as to the particular steam locomotives referred to representing the best modern practice, which brings up the question—Why cite them at all?

It is not at all certain that the speed advantage claimed is by any means true where the steam locomotive is designed for the work.

Mr. Armstrong gives a comparative statement of the performance of two steam and one electric locomotive to which exception can be taken because the steam locomotives do not represent the last word as to those available, and the electric locomotive is on paper.

The table shown herewith gives data for a 2-10-0 type steam locomotive of which over 100 are in regular service and of which fortunately very full information is available from the locomotive testing plant. These locomotives were expressly designed to do all of their work within the economical range of steam distribution, the required power being obtained by increases in size of cylinders and steam pressure. While I have given the power at nearly the speed mentioned by Mr. Armstrong, the performance is excellent at double the speeds given, but the sacrifice in drawbar pull—from nearly

60,000 pounds at 14.7 miles per hour to about 43,000 pounds at 25.3 m.p.h.—would not be justified. The figures given are within the range where stoker firing is as economical as expert hand firing, with the additional advantage that the stoker does not get tired.

This is a special design in which the advantage is that it cannot be worked at uneconomical points of cut-off. At speeds and pulls where the usual design is also worked at an economical range its performance is about the same.

2-10-0 Type Steam Locomotive

Weight in working order	371,000 lb.
Weight on drivers	342,050 lb.
Weight on engine and tender	532,000 lb.
Drawbar effort at 14.7 miles per hour, 45 per cent cut-off	58,900 lb.
Gross tons (2 per cent grade)	1,280 lb.
Trailing tons	1,019
Coal per D. H. P. at this speed and cut off	2.8 lb.
Tractive effort at 22 miles per hour, 40 per cent cut-off	42,500 lb.
Gross tons	923
Trailing tons	662
Coal per D. H. P.	3.2 lb.
Tractive effort at 25.4 miles per hour, 45 per cent cut off	43,600 lb.
Gross tons	948
Trailing tons	687
Coal per D. H. P.	3.8 lb.

The Mallet performance given in Mr. Armstrong's paper is evidently that of one of the large compound locomotives. In all of these locomotives there is a tendency to choke up with increases of speed, due to increase of back pressure.

The same arrangement of limited maximum cut-off used in the 2-10-0 locomotive already described has been embodied in a simple Mallet now running. In brief, the improvements in the steam locomotive, if properly availed of, have much narrowed the field of economical electrification.

Stand-by Losses. While these losses are actual and large it is very difficult to fix their value, as they are so much affected by the use made of the locomotive. Where the average monthly mileage is low the stand-by loss is presumably high, and it is a part of good operation to bring up the average mileage as high as possible. When all is said the electric locomotive has still an advantage with respect to stand-by losses, provided there are sufficient trains in motion to smooth out the total demand on the power plant, which is assumed to be steam operated.

Weather. The independence of the electric locomotive of severe weather is another undoubted advantage, not so much because of the performance of the motors but rather from the avoidance of losses and delays due to ash-pit work and to frozen pipes and other parts, incidental to the presence of water on the steam locomotive.

Liability to Interruption. Electric operation is dependent on uninterrupted connection with the source of power. In the event of breakage of the line, especially of the overhead construction, the trains in the section involved are dead and cannot get themselves out of the way of the repair trains. On large systems it is customary to make great changes in the assignment of locomotives to clear up congestion at any point on the system; also, to avail of diversion routes on which steam trains may be moved around obstructions on the main line. The fact that the steam locomotive is a self-contained power plant is an immense advantage in this respect. In electric operation there is not this freedom of movement.

Speeds. The question of speed is evidently treated from the freight standpoint, for there has never been any question as to the speed capacity of well designed passenger locomotives, being far beyond that permitted by the rules. As I see it, the feature of high speed of trains is of less importance than uniformity of speeds of different trains. If tonnage trains had the same speed as preference trains, and could thus avoid the great delay due to side tracking of trains of inferior rights, far more would be accomplished than the mere saving in time over the division due to the increased speed.

Extent of Electrification. Where electrification is contemplated a very serious question is: What shall be its extent? Naturally the desire would be to wipe out as many as possible of the extensive accessories to steam operation. If, however, it becomes necessary to operate steam trains over the electrified section, it will obviously be necessary to retain water stations and possibly fuel stations, provided the electrified section is sufficiently long. This operation of steam locomotives under their own power over electrified sections would be necessary in case of redistribution and possibly in case of diversions where the electrified section formed part of the diverted line. Therefore, the claim for economy in doing away with these features of steam operation would probably not be realized.

Mr. Muhlfeld's Paper. Mr. Muhlfeld ignores the fact that the modern improvements which have so added to the performance of the steam locomotives are potential only. It is common for instance to so carry water in the boiler that the superheater becomes merely a steam dryer and its value disappears. In many cases because of neglect of damper mechanism or from dirty flues little benefit is derived from improved appliances. Modernizing of steam locomotives calls for intelligent use of these devices.

Conclusions. The electric locomotive or electric operation has in many cases undoubted operating advantages because the power is generated in quantity at few sources and the power on any one train is not limited by the capacity of a self-contained portable power plant; sustained speeds are possible due to independence of fuel and water stations and, as a result of both these conditions, better use can be made of a given stretch of road.

Electrification does not at all obviate the numerous class of delays due to the train itself, such as hot boxes or other of the numerous derangements which when combined so much retard the movement over the road. Electrification does not obviate that class of delay arising from necessary classification on line of the road to meet terminal requirements. Where the terminal conditions limit the capacity of the road as a whole electrification is not the remedy.

The relative cost of repairs of both classes of equipment cannot be fairly stated at the present time because maintenance conditions are so abnormal and because the most modern locomotives of both classes are too new to have reached a stable condition, this being especially true of the electric one. While the indications are that the maintenance of the electric locomotive will be less than that of the steam, it must be remembered that the electric locomotives are dead affairs without the necessary electric generating, transmitting, converting and track appliances, all of which are an added expense, due solely to electrification; hence the cost of maintence of all of these, in addition to that of all of the locomotives, divided by the locomotive mileage, is the real treasury cost of maintenance per locomotive mile.

It is to be noted that practically all of the electrifications on steam railroads so far have been based on local conditions. In the electrifications in and around cities a moving cause has been the elimination of smoke and other objectionable features incidental to steam operation, and the possibility of increasing the capacities of the passenger terminals. On the Milwaukee road it was the utilization of available water power. On the Norfolk & Western it was to secure increase in capacity on a congested mountain division with tunnel complications.

If, after careful consideration of the road, based on actual train sheets for the heaviest actual or probable congested operation; the capacity and number of active and available locomotives required; crediting the operation with incidental savings which may be effected, and eliminating expenses peculiar to steam operation; it appears that there would be economy in electrification, either from actual savings or better operations, or both, it still remains for the management to decide whether the money required can be spent to better advantage for electrification than for some other features.

LOCOMOTIVE TERMINAL AS AN OPERATING FACTOR*

Satisfactory Locomotive Operation Dependent On Adequate Locomotive Terminal Facilities

BY L. G. PLANT

Associate Editor of the Railway Mechanical Engineer

THE importance of the locomotive terminal as an operating factor lies clearly in the fact that both the quantity and the quality of work performed by every locomotive depend wholly upon the character of the attention which it receives at the end of the run. The most efficient locomotive may become wasteful or the most powerful locomotive be incapacitated by careless handling or neglected maintenance at the locomotive terminal. When we stop to consider that the average locomotive spends the better part of each day in the terminal and that its ability to render useful service during the remaining hours depends upon the car which it has received at the terminal, it must be evident that the locomotive terminal is a very live factor in the operation of any railroad.

The effect which a terminal can have upon the performance of every locomotive is so very obvious that any broad plan for the betterment of operating conditions must take into consideration the question as to whether a further expenditure in terminal equipment or improvement in terminal methods will not enable us to get more useful work out of our locomotives without a corresponding increase in operating expenses.

We are today operating bigger locomotives than were thought practical twenty years ago and some of them are equipped with devices designed to increase the efficiency and capacity of the locomotive beyond what was considered possible ten years ago. But we are handling many of these locomotives through terminal lay-outs and in enginehouses that were designed over thirty years ago with small margin for subsequent development. Thirty or forty years ago the locomotive terminal was hardly regarded as an operating factor; other causes determined the hours that a locomotive was available for service and there were fewer repairs required in the roundhouse because the locomotives were subject to less intensive operation, because all of their parts were much lighter and because of the willingness with which the engineers cooperated in those days in the maintenance of their locomotives.

Function of the Locomotive Terminal

This brings us to a consideration of what is now the function of a locomotive terminal. It must, in the first place, afford adequate current maintenance. It may be possible and economical to concentrate the larger share of this burden at one of two adjacent terminals, but there are few terminals at which locomotives can be regularly turned without requiring the attention of mechanics. It may also be anticipated that the inspection required by the government will grow more insistent so that there are practically no locomotive terminals today in which adequate maintenance is not regarded as the foremost problem.

Generally speaking, terminal maintenance should be of such a character that the locomotives will continue to operate at full capacity and maximum efficiency between shoppings. Not only this, but the organization and facilities at every terminal should be adequate to keep all locomotive fuel and labor saving devices in working condition. Inability to properly maintain such devices with the terminal facilities on many railroads has been one of the most serious conditions tending to limit their full field usefulness. It is inevitable that locomotive terminals will be called upon to execute an increasing variety of heavy repair work, and it is imperative that they be so equipped that this work can be done without infringing on what may be described as the routine functions of the enginehouse.

The assignment of one or more stalls in a busy roundhouse to locomotives undergoing heavy repairs where the facilities are inadequate and the work consequently allowed to drag indicates a failure to comprehend the true function of a locomotive terminal. But, on the other hand, if the facilities are such that this work can be done expeditiously and economi-

*From a paper presented before the New England Railroad Club on November 9, 1920. An abstract of the concluding portion will appear in a subsequent issue of the *Railway Mechanical Engineer*.

cally this will do more than any other factor to prolong the useful service of locomotives between shoppings as well as lessen the ultimate maintenance cost.

Importance of Prompt Terminal Movement

A locomotive is of value only when it is performing useful work, and as it can only perform useful work when it is in service, it is startling to note how small a percentage of time locomotives on many railroads are in actual service even when traffic demands are very heavy. This is not necessarily a situation for which the mechanical department is responsible as the manner in which the power is dispatched by the operating department may cause much lost time. But terminal management and the terminal facilities at the disposal of the mechanical department are in most cases the controlling factors.

The cost of a locomotive is no index to what its actual value to the railroad company may be. If it is not a modern locomotive and the demands for power are such that it can be spared from active service it is valueless for the time being and should be stored for some future emergency. If on the other hand it is an efficient unit and the demands for power are pressing, it may easily be worth one hundred dollars for every hour that it is in active service. The value of locomotives will inevitably increase, and with an era of intensive railroad operation before us, we are unquestionably facing the ultimate pooling of all locomotives.

These facts only serve to emphasize the tremendous importance of speed in terminal operation. The function of the locomotive terminal is not only a matter of maintenance, but the execution of repairs and the routine operations of fire cleaning, coaling, sanding, washing and so on, within the shortest possible time. The significance of the prompt execution of these functions will be more fully appreciated when applied in principle to any railroad on which the demands for power are particularly heavy. Assuming that 1,000 locomotives are in service on an average of ten hours each day; if the terminal detention could then be reduced an average of one hour per day, this would be equivalent to an immediate increase of 100 locomotives in the number available for service.

It is the physical equipment, the organization and management of the terminal that determine its capacity to fulfill these important operating functions. Each new terminal development presents a unique problem which can best be solved by engineers acquainted with local conditions.

Essentials of Terminal Equipment

The essential features of locomotive terminal equipment may be roughly divided into outside equipment including the track lay-out, fire cleaning facilities, coal chutes and sanding apparatus; and the equipment which is distinctly a part of the enginehouse and adjacent shops. Where lack of foresight has not set a limit to the space available for expansion, trackage should be expanded to the fullest extent possible. A single track lead over which locomotives move to and from the roundhouse is inexcusable. Where trackage is ample, a well-defined routine for the movement of every locomotive can be strictly adhered to. With three or more tracks available, a majority should ordinarily be assigned to in-coming locomotives. As a general rule a number of short leads are preferable to a single long lead, as this enables one locomotive to move independently of other locomotives. Where the number of leads is restricted, frequent cross-over switches should be placed so as to reduce the liability of blocking the movement of any locomotive.

From an operating standpoint, the relative merits of various means for coaling and sanding locomotives may be gaged principally on the basis of reliability and capacity. Since the operation of these facilities reflects an operating charge, it may be well to consider the relative cost of operation, but this is not a circumstance to the necessity for reliability in operation and capacity, not only for the total daily quantities of coal and sand, but for the number of tracks served. While there may be some advantage in locating these facilities so that coal and sand may be taken together, there is apparently no real necessity for this, as it is not usually practical to deliver both coal and sand without moving the locomotives during the operation.

The arrangement of fire cleaning facilities and ash handling apparatus is undoubtedly the most vital feature exterior to the enginehouse. Whereas the time consumed in taking coal and sand can hardly be in excess of ten minutes, the time over the ash pit may easily consume one or two hours unless this movement is subject to the strictest supervision and the facilities are reasonably adequate. And yet these facilities at a very large number of so-called locomotive terminals are of the most meagre and primitive character.

Important Details in Terminal Equipment

No single feature about the terminal shows a greater variety in design than the locomotive ash pit. While we are accustomed to everything from an ordinary stretch of track on which the ashes are unceremoniously dumped, to extensive subterrannean vaults from which the ashes are removed by mechanical conveyors, I am inclined to think that the water pit with a single gantry crane spanning three or four locomotive tracks and a single cinder loading track will prove to be the ultimate type best suited to meet the demands of intensive terminal operation. The transverse pit serving several tracks is preferable on general principles to the longitudinal pit serving but one or two long tracks. It may be stated that in the most recent terminal projects where space could not be regarded as a limiting factor, short transverse water pits serving three and four locomotive tracks are decidedly in vogue. In any event, the locomotive ash pan should be accessible to fire cleaners working on either side of the locomotive. This may be accomplished on water pits by spacing the locomotive tracks close enough together so that light movable platforms may be used between them or by providing an individual water pit with each locomotive track that is spanned by the crane.

Against the possibility of a break down on the part of the ash pit crane, a locomotive crane should always be available. In fact, the locomotive crane, ready for any emergency and capable of doing many things, must be regarded as indispensable to the operation of any real locomotive terminal.

The washing of locomotives with oil, water and compressed air appears to be an accepted time and labor saving practice. Some of the best results observed in cleaning locomotives by this process are noted at terminals where during the day shift every incoming locomotive is washed off en route from the ash pit to the enginehouse. Two men were engaged in the operation, which ordinarily does not delay the locomotive to exceed five minutes. This method would seem to have advantages over the practice of washing locomotives periodically and doing this in the enginehouse.

Enginehouse Design and Equipment

From an operating standpoint it may be said that there are some facilities which are indispensable to the enginehouse while the necessity for certain machine tools and other special equipment might depend upon the proximity of the terminal to the backshop. With the increasing weight of locomotives and growing appreciation of the value of every locomotive service hour, we are faced, however, with the practical necessity of doing more and more heavy repair work in the locomotive terminal.

It is important, therefore, that in all new terminal projects this situation be taken into account and the enginehouses be fully equipped for any repairs that may reasonably be anticipated. In some of the most recent and important terminal

developments, the enginehouse in reality approaches the modern erecting shop in design and equipment. These roundhouses comprise about thirty stalls occupying approximately a semi-circle. The depth of the house is 115 ft., having a cross-section which resembles that of an erecting shop of a three-bay construction. This includes a lofty bay in which a 75 ft. 15-ton crane operates along the outer side of the house and two lower bays at the turntable side. The outer wall, which rises to a height of nearly 40 ft., is comprised almost wholly of steel sash, which, together with continuous monitor windows 15 ft. in height over the lower bays, provides unsurpassed natural illumination.

Adjustable standpipes, resembling water cranes are located between the stalls in such a position that they may be fitted over each locomotive stack. All smoke and gases are then removed by means of a down draft system, so that there are no smoke jacks to interfere with the operation of a crane throughout the entire circumference of the house. This down draft feature is also relied upon in building fires, thus eliminating the use of the steam blower and blower lines. While a blower fan is installed to create the necessary down draft, the stack erected outside of the house is of sufficient height to effect a strong natural draft when the fan is not in operation. Separate drop pits to serve trailing, main and and engine truck wheels are installed. The machine tool equipment at these terminals ranges from a comparatively small number of machines located in an annex to the roundhouse to a full complement of heavy machine tools in an adjacent erecting shop. The annex equipment includes a wheel lathe, boring mill, planer, motor driven lathes and unwheeling hoist, while the shop adjacent to other engine houses has the traveling crane and other equipment conventional to erecting shop lay-outs.

In fact, it is not beyond the range of possibilities to conceive of a development in locomotive terminals along these lines that would supersede many of the functions of the central erecting shop. While this is a subject more closely related to locomotive maintenance than to operation the question may well be raised as to whether better results could not be obtained from an operating as well as a maintenance standpoint if facilities were such that it would be practical to keep locomotives in good condition by frequent and adequate terminal repairs than by executing only the most urgent repairs in the terminal and relying largely on periodical backshop operations.

The Most Important Facilities

Of the particular features regarded as essential to the most successful operation of terminal enginehouses, those which tend to reduce labor costs are of the first importance. On this ground a traveling crane or electric tractor that would have been considered an extravagance ten years ago might well be regarded as a necessity on the basis of present labor costs.

Splendid results, however, can be obtained by equipping the roundhouse with two jib cranes between each stall located so as to swing over both ends of the locomotive boiler. It is entirely practical to build a jib crane with a toggle joint which will enable it to swing in a complete circle of 15 ft. radius about the column (as described in the August, 1920, issue of the *Railway Mechanical Engineer*, page 544) and to equip these jib cranes with two ton chain hoists. In fact, some foremen would prefer a roundhouse well equipped with jib cranes of this character to having a traveling crane where the repairs required are not too heavy.

The only definite suggestion which can be advanced in regard to this feature of roundhouse equipment is that in all new projects where the development is on an extensive scale the enginehouse should be made ample in size and equipment to allow for a wide variety of repair work without interference with the routine operating functions. The equipment in such cases should include the overhead traveling crane and downdraft ventilating apparatus. Where the activities of the enginehouse are limited to routine operating functions, the use of jib cranes are satisfactory and, if supplemented by an electric monorail or storage battery tractors, will meet every practical requirement.

Nothing need be said in regard to drop pits further than that they, or the equivalent in the form of an unwheeling hoist are essential to any locomotive terminal responsible for the maintenance of power in satisfactory running condition between shoppings. A number of well arranged drop pits are preferable to a single unwheeling hoist in the roundhouse, but where an annex is designed to care for the heavy repair work originating in the terminal, the unwheeling hoist would appear to be the most practical apparatus for such shop facilities.

It may also be said in a general way that the heating of enginehouses by steam or air even in the southern states is essential and that good ventilation and lighting are very important. Good floors will further contribute indirectly to the prompt movement of power through the enginehouse. The operation of the hot water washout system, on the other hand, has a direct effect on the operation of the railroad by reducing the time locomotives must be held in the enginehouse as well as exercising a very wholesome effect on boiler maintenance, and no locomotive terminal is in any sense complete without this equipment.

KINDS OF FUEL AND OPERATING COSTS*

In order to get the greatest return from money invested and the maximum of efficiency, it is necessary to have complete co-operation among the departments chiefly concerned in the purchase, inspection, distribution and handling of coal. Any failure of one or more departments to fully co-operate with the others in any particular feature or situation concerning fuel, exposes that railroad directly or indirectly to a loss. The effect of the changing grades of coal is soon felt, both on the performance of the engine and the operating costs. One of the most important effects is on the morale of the men. The modern locomotive long ago reached a size that is above the limit of human endeavor to fire by hand and also give the care and attention necessary for the economical use of fuel when different kinds are being continually furnished.

From an economical standpoint, prepared coal, even at a higher cost, is best, due to the elimination of delays caused by steam failures, and it is better adapted for stoker service, on account of being the proper size and free from foreign materials. In many cases the firemen do not break lumps to the proper size and remove foreign material before feeding the unprepared coal to the stoker.

With a grade of coal of a low heat value, and the locomotive equipped to handle it economically and successfully in short haul or local service, when the same uniform grade of coal is regularly furnished, the operating cost can be maintained at a minimum and a satisfactory service guaranteed. It has been proved that, with locomotives so equipped, when it became necessary to furnish them with a grade of coal of a higher heat value the cost of operation in the same service increased far more than the difference in the cost of coal, due largely to the draft of the locomotive and the lack of care and co-operation of the engine crews after the change of fuel was made.

With a grade of coal of a high heat value, usually furnished for long haul, heavy or first-class service, and with locomotives equipped to handle it economically, after a long established and satisfactory service has been maintained at

* From a paper presented at the convention of the Traveling Engineers' Association.

a minimum cost, this same service has been badly disarranged and the cost of operation largely increased when it became necessary to substitute a grade of coal of a low heat value to locomotives so equipped. In this case operating costs are increased because of the additional supervision necessary in the operating department, extra help necessary at intermediate points, extra pay to engine crews for fire cleaning, ash-pan cleaning, etc., required operating agreements, which accrue before changes in the construction of the equipment can be made. Added to this is the maintenance of the engine.

Because of the scarcity of coal at the present time, railroads are using a large amount of commercial or confiscated coal, which disrupts the regular assignment and raises the price per ton far above the regular contract price.

Some mechanical coaling stations have a tendency to separate run-of-mine coal so that lumps will all be on one side and fine coal on the other. Nothing is more discouraging to a fireman than to go out on the road with a heavy hand-fired locomotive supplied with fine coal and then see a yard engine coaled with clean lumps.

We recommend standard nozzles, front ends and equipments, but it is impossible to maintain them as standard without some knowledge of the character of the coal to be used, as it requires time (which is money) to make changes in locomotives to meet requirements of frequently changing coal. After locomotives are once equipped to handle a certain grade of coal, it is impracticable to be continually changing the front ends to suit different grades.

Distribution

It is a prevailing practice that fuel distribution be left in the hands of the fuel accounting or purchasing department. This practice is approved by the committee when coal of the same grade or heat value is purchased exclusively; but on any division or system where various kinds of coal of different grades are used and the grade and quality of the coal are known, the distribution should be under the direction of the officers of the locomotive department, who maintain the power and know its condition and are better able to state where various grades can be used to the best advantage.

An important feature of fuel distribution is to order and insist on the proper kinds of cars. It means an item of increased expense when the unloading has to be done contrary to the usual method.

Pulverized Coal

For good financial reasons, during the war period the railroads practically abandoned experimenting with and using pulverized coal. No doubt in the near future they will give this subject deserved consideration. Experiments made in the past seem to prove that there is much merit in the use of coal prepared in this manner. While many are enthusiastic relative to its merits, the committee has been unable to get any definite information of statistics relative to its regular use in locomotive practice.

Storage

Storing should preferably be done at the coaling stations or power plants, but when this cannot be done, coal should be stored as near to the point of consumption as possible.

So far as it can be brought about, only one kind of coal should be stored in the storage pile. Experience indicates that mixed coal loses more of its value and is more liable to spontaneous combustion while in storage than coal of one kind, under the same conditions. Chemical tests show losses of from one to five per cent if coal is kept in storage for periods from a few months to several years. Stored coal may not ignite as quickly as fresh coal, although there may be no difference in the B.t.u. value by test.

Oil

With the increased demand for domestic crude oil, from which nearly all of our lubricating oils and greases are made and upon which even the industrial life of the nation depends because of the great increase of internal combustion engines that can use no other fuel, it becomes almost a crime to waste this grade of crude oil as a steam producer, in so far as railroads are concerned. Unless greater fuel oil deposits are discovered and the cost of production decreased, which does not seem possible at this time, the most recent statistics on the production, storage and consumption of oil as a fuel clearly indicate that the day is not far distant when it will be prohibitive for locomotive use and it will become necessary to use some form of power obtained from a lower grade of fuel.

The report was signed by J. A. Mitchell (N. Y., N. H. & H.), chairman; E. F. Boyle (Sou. Pac.), H. H. Kane (Sou. Pac.) and G. V. McGlinch (M. C.).

Discussion

It is evident that the shortage of coal for the past year has led to extremely unsatisfactory conditions with respect to locomotive fuel and these conditions have clearly demonstrated the desirability of the maintenance of a uniform supply of coal on each division.

Several systems of distribution were briefly described. On the Louisville & Nashville coal is billed direct from the mine to the division, each division thus securing a uniform quality of coal, always from the same mine. Where coal is shipped from off the line, however, this practice was objected to and some system of distribution after the coal is received on the line seems to be necessary.

The abuse of the reconsignment privilege was referred to as one of the causes of coal car shortage, the cars thus being tied up under load so far that in some cases the roads are unable to get cars for their own coal and must confiscate anything available.

Referring to the difficulty of securing uniformity in the distribution of coal under present conditions Robert Collett described the method being employed on the New York Central. A statement is issued periodically showing the distribution as it should be made, in comparison with the actual distribution and giving the per cent of incorrect distribution. This served as a lever to bring about improved conditions.

Photo by International

An Accident Near Manx, Nevada, Due to Spreading Rails in Which the Entire Train Left the Track, Causing Four Deaths

A View of the Readville Shops of the N. Y., N. H. & H.

Closing Sessions of C. I. C. I. & C. F. A. Convention

Handling Tank Cars, Loss and Damage, Passenger Car Maintenance and A. R. A. Billing Discussed

The proceedings of the opening sessions of the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association were published in the November issue of the *Railway Mechanical Engineer*. At the conclusion of the discussion of the Rules of Interchange, as reported in the previous number, President Gainey introduced J. E. Grant and T. J. O'Donnell, special agents of the Bureau of Explosives, who addressed the convention.

DUTIES OF CAR INSPECTORS IN HANDLING TANK CARS

BY J. E. GRANT

No other rolling equipment of the American railroads today claims as much attention from the Bureau of Explosives as the tank car. It represents the development of a shipping container by means of which more lading of a character classified as dangerous by the regulations of the Interstate Commerce Commission and Canadian Railway Commission is transported than in any other way.

There is no class of car which should have the careful attention of a car inspector on the line or at an interchange point more than the tank car, and in view of its great importance in freight traffic, it will be interesting to trace briefly its development.

Tank cars are in a distinctive class from the fact that notwithstanding the enormous volume of their traffic, they are almost entirely privately owned. Of a total number estimated at about 125,000 the railroads own only about 15,000 of these cars.

Their range of ownership among the users themselves resulted during the first years of their existence in construction along the lines of individual ideas and until the year 1902 not much attention was paid to details of strength, materials or design provided they were mounted on frames and running gear capable of holding up in the general stream of freight traffic. In that year, 13 tank cars of naphtha were involved in an accident and as the result of the fire and explosion of several of the cars which followed 24 employees and others were killed and 291 injured.

Work of the Tank Car Committee

One of the results of investigation of this accident was the appointment of a Committee on Tank Cars by the Master Car Builders' Association. This action was at the request of the American Railway Association and the committee was charged to investigate and report on the question of proper design and construction of tank car equipment for the safe transportation of volatile oils.

It was found that the tank cars were inadequate to meet safe transportation requirements and recommendations were made to require strengthening of those already in existence, safety valves for the relief of internal pressure and the adoption of new standards for future construction of this class of equipment.

In 1910 the recommended practice was adopted as standard and the committee relieved. The following year, 1911, a Tank Car Committee was again appointed to take up the question of the shipment of liquefied petroleum gas or casing-head gasoline in tank cars in co-operation with Colonel B. W. Dunn, Chief Inspector of the Bureau of Explosives. The year 1912 marked the development of the insulated tank car for liquefied petroleum gas and also for liquid chlorine gas.

Up to the time of the first appointment of the Tank Car Committee the principal products of the petroleum industry shipped in tank cars had been kerosene or illuminating oil and the lubricating oils. Gasoline was more or less a by-product of their manufacture and internal combustion motors had only fairly entered their stage of development for industrial and automobile use.

Hazards in Shipping Gasoline

A steady and rapidly increasing demand for gasoline as motor fuel has continued from that time until today the supply is inadequate from the refining of the greatest petroleum production in our history. To meet the increasing demand it has been found necessary to supplement the refining process by manufacturing gasoline by liquefying the gases from oil wells. This gives the product called liquefied petroleum gas or casing-head gasoline, which either alone or blended with heavier products is capable of causing and has caused

more damage and trouble than any other commodity ever shipped by rail.

Its dangerous nature is due to its great volatility or rapid evaporation and its vapors like those of ordinary refinery gasoline are so highly inflammable that they will ignite and flash back at great distances from their liquid source. Casing-head gasoline also has a very low boiling point and a high vapor tension or pressure which results from a rise in temperature. These hazardous qualities call for the tank cars in which it is shipped to be in perfect condition as non-leaking containers and also have provision for automatic relief of interior pressure which may develop in the tanks beyond a point which might strain them or cause them to rupture. This protection, which is very important, is afforded by safety valves.

The regulations and tank car specifications provide for tanks and valves to be kept in serviceable condition by periodical tests which have to be reported to the Chief Inspector of the Bureau of Explosives. Barring accidents or misuse it may be assumed if the stenciled dates which must appear on each tank show such tests to have been made within the prescribed time limits that the tanks and valves are in proper condition for service.

Rules Safeguard Movement of Tanks

Unless involved in such an emergency as a wreck, tank cars should not be in a condition to permit the escape of an inflammable liquid, and without such escape there is no hazard of fire. Yet reports reach the Bureau of Explosives daily of instances where leakage is found at seams, rivets, bottom outlets or through insecurely closed domes. A. R. A. rule 3, section (e) shows that such a car (empty or loaded) will not be accepted in interchange. These conditions indicate either that the car was offered to the railroad in that condition by the shipper, or that the leakage developed in transit. If the car was shipped in that condition, the initial carrier failed through its inspector to comply with paragraph 1822 (f) which prohibits its acceptance. If leakage developed in transit, the car should have been taken out of the train as soon as discovered and if the leakage could not be stopped, the contents of the tank should have been transferred into another. This action is called for in rule 2, section (b). In these operations or any other where there is an escape of inflammable liquid the principal thing to bear in mind is that lights and fires must be kept away.

This precaution is the most important of all and from various sources of ignition up to a distance of 480 ft. the records of the Bureau of Explosives show tank car fires to have been caused by locomotive sparks, hot coals, lighted matches, cigars, cigarettes, back firing of automobiles, oil or gasoline lanterns, torches, switch lights, fireboxes, steam cranes and other similar causes.

Handling Leaking Tank Cars

Without doubt the most serious situation to deal with is that resulting from wrecks and derailments. Tank cars then lose their contents through leakage caused by rupture of the shells or displacement of bottom outlet valves or it is necessary to transfer their lading into other cars before the wreckage can be cleared up. In nearly every case where leakage takes place through damage to the tanks there is an immediate ignition from the sparks and friction of grinding metal in the wreck. A leaking tank is a reservoir which feeds fuel to the flames and seldom if ever are means available to extinguish the fire until it has gotten beyond control. Water will spread instead of quenching it and if it cannot be smothered by the use of earth, steam or wet blankets, all efforts should be directed without delay to saving other property.

In wrecks involving tank cars which do not leak or where there may be leakage which does not ignite, the action of those handling the situation is most important. The first thing to do is to move away all lights or fires of every description and police the location with reliable guards to see that this precaution is strictly observed. Any leakage should then be stopped or reduced as much as possible. The next step is to dispose of the leaking liquid so it will not create a hazard. This is usually done by draining into holes in the ground and then covering the area with loose earth. While this may delay the handling of the wreck it must be remembered that there is no possible way of safely handling such wrecks while gasoline is freely leaking from tank cars or while a heavy leakage has not already been taken care of.

While gasoline is actually escaping all lights and fires should be kept at a distance, this distance being necessarily much greater on the leeward than the windward side. The vapor being heavier than air flows along the ground and settles in low places. It may travel a considerable distance with the wind, though when the air is quiet it will tend to form a layer along the ground. With the exception of closed electric lights all necessary signal lights and lanterns should be kept elevated and on the windward side. After allowing reasonable time for escape of vapor from the leakage and buried liquid, a steam crane may be brought up on the windward side, but not within a distance of 500 ft. The least injured cars should be first handled and if it appears that further leakage is to be expected such tanks should either be transferred or emptied into holes or trenches in the ground for burial.

Safe Methods for Transferring Contents

In transferring lading from wrecked or leaking cars several railroads are successfully using the air pressure method and the steam pump. Air pressure will not be practicable where there is any appreciable leakage from the tank, and on some lines it is thought that whether or not the tank is ruptured the steam pump is better. These methods are now under investigation by the Bureau of Explosives and a circular will soon be issued giving details of various types of such equipment which have been found to operate satisfactorily.

Up to this time the bureau has details of the successful use on one of the largest Eastern lines, of the single acting Blake pump by steam taken from cranes or locomotives. One wreck train is equipped with one of these pumps 7 in. by 5 in. by 10 in. and another train with one 8 in. by 5 in. by 12 in. At a point on the same line where movement of cars to be transferred is safe, they are hauled to an oil plant, and the lading is pumped into other cars by triplex No. 4 or No. 6 steam pumps after being drawn into a ground line. At two of its shops, this road also transfers by air pressure of 6 to 8 lb. per sq. in. through piping from the bottom outlet of one tank to the dome of the other.

A large Western line is using the Blake type of pump 6 in. by 4 in. by 6 in. as a part of its wrecking equipment with standard Westinghouse piping where it is possible and standard air brake couplings. Air from the train line of the wreck train is used to operate the pump.

Transferring by Air Pressure

Another road in the Northwest has used air pressure from the train line when tanks are not leaking. A substitute dome cover is placed in position, which is tapped through for two 2-in. pipe connections. One passes through to the bottom of the tank for the discharge and the other merely admits air into the dome. The discharge pipe has an extra joint for lengthening or shortening to fit the diameter of the tank. A rigid discharge pipe, however, will not completely empty a tank that is not plumb.

Several roads in the Midwest are using air pressure from the train line with a special dome cover and flexible non-collapsible hose for the discharge line. This arrangement by dropping the end of the discharge line into the lowest part of the tank will practically empty it of all its contents.

The general principle in regard to pumps for such use is that any pump which will operate on steam will also operate on air; and since these operations are to handle liquids under low head, any good type of steam pump having relatively large water cylinders and metallic valves should answer the purpose. In addition, since it should be portable so as to permit placement in various locations necessary for use, lightness is also essential.

With the air pressure method it will be understood that the safety valves on the tank will not permit use of more than 25 lb. per sq. inch, so no attempt should be made to exceed that amount. It has been demonstrated that pressure considerably lower will accomplish the necessary results. The special circular which I mentioned will be issued by the bureau at an early date and will give data covering various details of the required materials and assembly of apparatus together with rate of flow in transferring and approximate costs.

Other Dangerous Shipments

Other commodities with inflammable hazards such as alcohol, benzol, benzine, naphtha and carbon bisulphide are transported in tank cars as well as acids, sulphuric and mixed, which are highly corrosive and therefore classed as dangerous. Liquid chlorine gas and sulphur dioxide, both highly volatile and poisonous, are considered as especially dangerous because of this characteristic and require specially strong and insulated cars the tanks of which are entirely welded and built without the use of any rivets.

While these last mentioned liquids possess hazards peculiar to themselves, the handling of gasoline is by far the most important by reason of correspondingly greater hazards due to its greater volume of shipment. It is estimated that such shipments now move at the rate of more than 3,500,000,000 gallons annually.

From 1910 to the beginning of this year 117 people were killed on the railroads in the transportation of dangerous articles, other than explosives. Of this number 97 or about 83 per cent were killed by gasoline. Of 1,079 people injured, 684 or 63 per cent were injured by gasoline. Of the property loss amounting to $6,469,962 during those ten years, $3,215,922 or over 49 per cent was caused by gasoline.

Gasoline More Destructive Than Explosives

These statistics indicate that gasoline in disastrous results during transportation has shown itself to be many times as destructive as explosives and by a wide margin in point of hazard to life and property the most dangerous commodity from a railroad standpoint. The worst accident which has occurred in the transportation of explosives does not approach in effect the tank car disaster at Ardmore, Oklahoma, in 1915 when 47 persons were killed, 524 injured and property damage reached nearly $2,000,000.

In the face of this evidence of its terrible toll of life and property which has continued for years, the question naturally arises, "What is being done to prevent it?"

The Tank Car Committee with a membership composed principally of master car builders and selected as representing expert mechanical ability, has been faithful and untiring in its efforts to lay down requirements for the construction and maintenance of tank cars in the safest condition for such important service.

The Bureau of Explosives, with the advantages of research, investigations, the services of a skilled chemical staff and specially trained inspectors directed by a technical and mechanical expert, has had included in the regulations for safe transportation, rules which experience and a knowledge of dangerous products have shown necessary in proper preparation for shipment and safe handling in transit. These regulations have been supplemented from time to time by special circulars and bulletins, pointing out the lessons to be learned from failure to observe proper safety precautions and giving valuable suggestions and recommendations for suitable action to cope with various dangerous situations.

Notwithstanding all these measures, the loss of life and property continues. Some of it is unavoidable, as it has been truly said that as long as railroads are operated, wrecks will occur. Much is preventable, however, and the share of responsibility which falls upon the car foremen and their inspectors in line and interchange work is by no means light.

Weak Points of Tank Cars

The present types of bottom outlet, dome opening and safety valves are three weak points of tank cars. On account of the fact that records show the bottom discharge outlet responsible for 95 per cent of the leakages from tank cars, the chief inspector of the bureau last year recommended its elimination entirely. This would necessitate unloading through the dome and the suggestion was not favorably received by the oil industry and tank car owners. Their acknowledgment of the inadequacy of this outlet, however, was immediately shown in co-operative action through the American Petroleum Institute to develop a leak-proof valve and a subcommittee of the Tank Car Committee has also been active along the same line. Several types have been investigated and a number are now installed on tank cars for trial in actual service tests. Improvements in dome covers and safety valves are under investigation to develop types which will not permit the escape of vapor.

In addition to the precautions I have mentioned I would suggest the importance of impressing strongly these points in the minds of your inspectors. Remember always that the warning on the placard attached to a tank car loaded with an inflammable liquid means just what it says, "Keep lights and fires away." A leaking tank car of gasoline is a fire trap and if you pass one through on your inspection it may cause the death or injury of one of your fellow employees and others along the line. A loaded tank car is top heavy and if a side bearing is missing or the clearances are too great it may rock off the track and cause a serious wreck.

Bottom Outlet Requires Attention

If the outlet valve is defective or not closed the outlet chamber in cold weather is liable to burst from the freezing of water which settles from the gasoline and leaks into it, and if you discover such a condition by detecting a crack in the side of the nozzle, serious trouble will be avoided later by prompt arrangements to transfer the contents into another car.

If your work is where loaded tank cars are received from shippers, satisfy yourself that the cars are being loaded with the valve caps off. Then you will know that the outlet valve is closed and if the valve cap is lost or the outlet chamber broken off the contents will not leak out. If you have any doubt that shippers are loading without this precaution, arrange to have some of the valve caps removed occasionally before the cars are pulled out to see if the outlet valves are closed and in proper condition.

Examine the stenciled test dates for the tanks and safety valves and if you find either or both overdue, the car should not be forwarded under load. Rule 3, section "p" of the Interchange Code tells you that tank cars, the safety valves of which are due for test within 30 days, will not be accepted. Rule 16 provides that a road having in its possession a tank car due for test of safety valves must make such tests in accordance with the tank car specifications, billing the owner for the cost of same. Rule 9 provides for this and requires a certificate for such test to accompany the billing repair card.

Rule 2, section "b" states that "A leaky tank car shall have stenciled on it, in letters three inches in size, adjacent to the car number, the words 'Leaky tank. Do not load until repaired,' and the owner shall be immediately notified. Sten-

ciling must not be removed until the tank is repaired." This rule is designed to show the owner or user that a tank must be repaired before further use and will apply most often when transfers of lading are made in transit. Another important rule is No. 32 showing delivering companies responsible for missing dome covers and safety valves.

Proper Use of Placards

Remember that all tank cars loaded with inflammable liquids must bear two cards showing the proper classification name of contents and four "Inflammable" placards. If these markings are lacking do not pass the car until they are applied by the shipper or if they become lost in transit see that they are replaced before further movement. Rule 36 covers this and rule 107 provides for the charge for the service.

Any tank car containing liquefied petroleum gas or casing-head gasoline must also bear three white placards on the dome, two on the sides and one on the cover to warn against its removal while any interior pressure exists. Do not remove the dome cover of any such car unless absolutely necessary and this only in a location safe from the danger of lights and fires and after pressure has been removed by raising the safety valve. The boiling point of casing-head gasoline is low and any agitation of the tank will be very liable to cause the liquid to rise and overflow.

Precautions to Be Observed at Night

Never go up around the dome of a loaded tank at night with an ordinary lantern or torch. Use an electric flash light or an electric lantern. In approaching tank cars at night be constantly alert to detect the odor of possible leakage, remembering that the sense of smell if normally developed, is a good guide to warn of such hazards and the great danger is that of igniting the vapors rising from the leaking liquid.

Familiarize yourself with the specifications for tank cars and regulations and rules governing their proper physical condition and placarding. Obtain through the proper official of your line and read copies of bureau publications dealing with the hazards and proper handling of tank car shipments of dangerous articles, especially Circular B. C. L. No. 189, Handling of Wrecked and Leaking Tank Cars and B. E. Pamphlets Nos. 20-I and 20-J, Condensed Instructions for Wreck Crews and General Mechanical Superintendents, Chief Car Inspectors and Car Inspectors.

The prime object of your association and the practical aim of your personal vocation is to maintain equipment in the required serviceable condition for safe transportation. This is common to the purpose of the Bureau of Explosives, and we should all use our best endeavors to meet our share of these responsibilities for successful accomplishment of the greatest enterprise in the world, the operation of the American railroads.

President Gainey thanked Mr. Grant, on behalf of the association, and introduced J. O'Donnell of the Bureau of Explosives.

Address by Mr. O'Donnell

The interchange man is first confronted with a dangerous article by the placard on both sides and ends of the car, placed there before the car reaches the inspector. The method of manufacture of these dangerous commodities known as explosives and other dangerous articles, must be open to the representative of the common carrier or the Bureau of Explosives. The United States goes back to the very beginning and sees that it is made so that it will be safe to transport. Quite a lot of the most dangerous of all explosives are not allowed to be transported. For instance, nitro-glycerine and dynamite that contains more than 60 per cent nitro-glycerine, except in gelatine form, and in this form the type of package is specified and limited in weight so that each package can be handled practically by the effort of one man in an emergency. After doing that, if its shipment is to be presented in less than car load lots, there are certain labels designated for the dangerous articles other than explosives, alike in form and in marking. There is a tremendous safeguard in so doing because the freight handler knows them wherever he sees them, and so they are always alike. The labels are standard. The principal use of these labels is in warning the individual of a dangerous commodity; they also tell the kind of a placard to put on a car, for the car must be placarded.

One of the greatest problems that we had to deal with in the early days of this movement was the number of placards that were moving in transit. You can see that the fewer cards there were the greater the respect would be for them; that is why Rule 107 lays down a specific charge for removing cards that are unnecessary; also when placards are missing, a charge for applying.

The car load lots that you see moving are practically all loaded by the shipper, and he has to load according to a certain specified standard. The very bracing that he uses is specified. It must be no less effective than that laid down by the bureau for his guidance.

When the car arrives at interchange and you see the placard, a number of safeguards have already been taken, and the placard is there to warn you that you have a dangerous commodity in the car and you must handle it accordingly. You will also notice on the side of an explosive car that there are car certificates which state positively that the car passed a careful inspection; that it is a standard car of not less than 60,000 lb. capacity, and where possible it must have a steel underframe and friction draft gear. It must have no loose bolts. The roof must be sound, running gear in good condition, journal boxes packed in oil, and if there are draft bolts sticking through the floor they must be covered and beveled on the ends.

This car demands your most careful attention, and the rules laid down in interchange say you cannot offer such a car for transportation unless in proper condition. You cannot make any arrangements by which you can give that car to a connecting line if it is not in good condition. If it is discovered in bad condition on a receiving line, it cannot be moved back to you. That is a wise regulation because in a crowded terminal there is too great danger of shuffling these cars back and forth.

The interchange inspector is particularly interested in that car because he must go around it; see that from the outside it is in apparent good condition to travel; that the placards are on, and if there are any signs that the car has received rough treatment, he must open the car and inspect the lading. Some roads make a practice of opening all placarded cars on the receiving line; the regulations do not require that, but they do say if there is any apparent damage to the car, you must open it because the lading is of such a nature that you cannot afford to take any chances.

Another class of cars is that placarded "Inflammable." With explosives, unless there is a shock or friction, there is no danger of an explosion. But in approaching a car that is placarded "Inflammable" it is possible that it may be leaking, and bringing your lantern or lamp near, it will cause a fire from the inflammable vapors. So great care should be taken when you see an "Inflammable" placard. Above all things the warning on the inflammable placard should be strictly obeyed—never to bring lights or fires near that car, unless you know there is no leakage there.

Suppose you have a cut of cars moving on A road, transported to B road, standing on interchange, usually at night; it is dangerous for any inspector to take his lamp and begin to go down that cut of cars, not knowing but what some of the inflammable liquids may be pouring out and the wind

blowing that vapor towards the light. I have known of a case where the vapor has reached a fire 480 ft. away and flashed back.

The dominant idea when an inspector sees a placard should be that that placard is for a purpose and that purpose is a warning.

There are a few things I would like to say about tank cars. At St. Louis there are 1,250 tank cars placarded every day. The St. Louis plan is the ideal plan; that is, that every railroad company of any size that handles these tank cars ought to have a trained expert in the person of one of their inspectors whose particular duty it is to learn all he can about tank cars.

One of the best ideas I could leave with you who are in charge of men is to recommend that you take some man who you see is especially interested in this thing and encourage him—give him all the literature you can find on the subject, and when you have a leak or a wreck you will have a valuable asset in this man, who will detect danger at once if other men are careless.

There have been great improvements in tank cars. The head block is gone; the old patched sheet is gone; the old 40,000 lb. tank is nearly gone. The tank that had a shell like a patch of paper is gone. Now we have periodical tests. The 12 lb. valve is nearly obsolete. We have a 25 lb. safety valve, and in a little while we will have a bottom outlet valve, and we will have done a great deal.

I hope that what I have said to you will have some effect; that you will go home with a renewed idea that these regulations which you see for the safe transportation of explosives and other dangerous articles, as they appeal to the car men, will be renewed under your supervision; that the men will be given strict orders; that these are not railroad regulations; that they are Federal laws and must be obeyed. Some penalty is laid down, but we do not want to threaten a man with penalties, because a man who works under duress is not a good man. We want it done because it is the only safe way to do and because it is the law of our land. (Applause.)

Discussion

President Gainey: I want to thank Mr. O'Donnell for his instructive talk that he has given us this morning. I know that what he has said to you is from his heart.

Talking of examining cars on the outlet valve, a few years ago I knew of a case where a train was running along and the cap came off at the bottom and a whole tank of oil was lost. On examination it was found that the tank was loaded with the valve wide open, at a point where there was no inspector. In testing the cap it was found to have five threads and it did not tighten until it got to the last thread. The cap loosened and worked off. I think it would be well to take these caps off once in a while to see whether the valve on the inside of the car is closed.

E. H. Mattingley: As we have a representative here from practically every road in the United States and Canada, I would like to ask how many roads handling tank cars have supplied their inspectors and the men having to do with the handling of tanks, with an electric lantern as outlined by the speakers?

W. P. Elliott: I will say the St. Louis Terminal has.

A Member: The Pennsylvania has.

E. H. Mattingley: I would move that it be the sense of this body that we recommend to our superior officers that all railroads having to do with the interchange or handling of tank cars, supply their inspectors with a special electric lantern or flash light for the safe handling of such cars. (Seconded by W. P. Elliott.)

T. J. O'Donnell: While I fully agree with the motion, I am wondering if Mr. Mattingley realizes what a great expense that is. Wouldn't this motion be better. That every car inspector be advised by the yard department when a string of cars pulls in, of the initial and number of every car that carries explosives or inflammable matter; then he will know where the car is and when to look for it. I think Mr. Mattingley realizes that while our suggestion is a good one, it probably would not be adopted right away because you would have to delegate one man to do that work. In our terminal we have tank cars going through 37 yards. I would have to have special men at different points. We accept from industrial plants large numbers, and our superintendents have recommended that when a car leaves the terminal each division superintendent will have definite notice what position that car has in the train, so that when our men start on it, they will know right away when to look for it.

E. H. Mattingley: How would you handle that car at night?

T. J. O'Donnell: Odor would be the first definite notice. The inspector should be extremely careful not to go near when the odor is heavy. I have never had an accident of that kind in our district.

J. O'Donnell: It seems to me that the most prolific source of accident is the switchman's lamp. I believe every one of us should keep that before us. It cannot be said that with the inventive genius of today, something could not be gotten up to take the place of that device which has caused many fires in tank cars. There is no use having a man with an electric flash light going to one particular car when you may have an engine passing, or a switchman going down to the rear end of his train with a lamp. Wherever it is known that leakage takes place, we have got to use an electric flash light or wait until daylight. But I believe it would be a good thing if this body would go on record to some extent favoring a change in our plan of lamps for inspectors. I would oppose all inspectors having flash lights for the same reason that Mr. O'Donnell does, but I do say that we ought to have them.

T. S. Cheadle: I think it would be a good thing to have the class of the car stenciled on it. I understand that class 2 could be changed to another class; when it is loaded the man loading ought to be required to change the class of that tank.

E. H. Mattingley: The object I had in mind was that safety first should be and must be recognized, regardless of cost. If the fires which these gentlemen have described are caused, and will continue to be caused, by the open flame light, then, regardless of what it will cost to equip railroads, something of this kind should be prescribed for the inspection and handling of tank cars.

We all know as car men that it is the first duty of the car inspector to detect the trouble. If he finds a leaking tank he notifies the yardmaster, or the proper man in charge of the yard which is concerned, yet the only way he has of knowing the tank car is leaking is by the sense of smell. How many car inspectors will attempt to make repairs and carry a flame light by night while making these repairs? Therefore, in justice to our car inspectors and in harmony with the safety first movement, I would recommend that switchmen and car inspectors who have to do with the handling of tank cars and other cars containing inflammable liquids or explosives, be provided with an electric light, or some improved method.

W. P. Elliott: I believe if you would poll the railroad companies, you would find that they are doing that now. The inspector is the man who is notified nine times out of ten and he will take care of it. When he goes down, he has got to have something besides his lighted lantern. It isn't necessary that each individual inspector have an electric lamp if they are kept on hand so that the men who need them may use them.

E. H. Mattingley: I did not mean that the entire car inspection force should be equipped with an electric lantern, but possibly two to six lights, as may be deemed necessary, could be provided, according to the number of tank cars re-

ceived at that particular yard. I think the lights should be there, but I fear that is not the case in a great many of our large terminals at the present time.

A. Berg: These requirements are already met on our line and have been for a considerable time.

(The question was put upon the motion and the motion carried.)

G. Lynch: Mr. Grant's paper and the able address of Mr. O'Donnell were both very instructive, and I move you that a vote of thanks be extended to these gentlemen and that their remarks be incorporated in the minutes of our meeting. (Seconded and carried.)

President Gainey next introduced E. Arnold, general claim agent of the Grand Trunk.

Address of Mr. Arnold

As a Canadian who has lived half his life on the other side, I want to welcome you to Montreal. The railroad organizations have had some of their most successful meetings in this town, and the Canadians as a whole are very fond of their American cousins. We believe about the same as you do, and the Canadian lines have followed closely all of the rules of the American associations and have respected and upheld them all the way through.

I have been much interested in the remarks of the representatives of the Bureau of Explosives. We have had some very heavy claims on account of the transfer of oils from tank cars containing a high class oil to other tank cars that were not properly cleaned. I have seen several claims amounting to from $1,000 to $4,000 because the cars to which the oil was transferred were dirty, or contained inferior oil, and thus damaged the oil and made it unfit for the purpose for which it was intended. I do not know whether the car men are vitally interested in that, but they usually decide whether a car is fit for transfer or not.

Another thing which I brought up personally before the A. R. A. is whether we cannot get tank cars with the valve at the top instead of the bottom. If the valve breaks the car may leak for hours and the train men are unable to stop it; consequently oil of the value of from $2.00 to $4.00 a gallon is leaking along the entire right of way. With all of our American and Canadian inventive genius we ought to be able to invent a tank car without a valve at the bottom. In the large oil districts we have endeavored to have a change of that kind brought about.

The A. R. A. executives are much exercised at the present time on account of the large sums we are paying out in loss and damage. It is a subject that has been very close to me for a number of years and consequently I am very much interested in it.

I have a circular from J. E. Fairbanks, general secretary of the A. R. A., calling our attention to the large sums and asking us to get together and see what can be done. During 1919 the Class I roads alone paid out $104,000,000 during the year for loss and damage. A good deal of that was due to defective equipment, and I know during federal control and during the war we have not been able to keep our equipment up as it should be. In consequence there is a great deal of poor equipment going over the roads. Also, on account of the immense volume of business moving, we have not been able to pick out cars for certain commodities that require good cars, as we have in the past.

During federal control we did not examine the cars at interchange points as we did before. We did not take the seal records, and in consequence the sums paid for loss and damage were double.

We have recently been granted a large increase in rates, and it behooves us to give the public the service that they are paying for, and they are going to be more critical in the next year than before they paid the higher rate. They are going to expect us to give them good service.

The A. R. A. has ruled on defective equipment and said that the carrier supplying the car must make a proper inspection through a representative; must keep a book record of that inspection and must show that every time there is a claim presented for damages, and if they are not able to show that on loading the carrier will be charged with the full amount of the claim. Claims of that kind have been prorated on a through mileage basis, and it has been carried by all of the cars instead of the one that was very often at fault. Beginning September 1, unless we have a book record, we have got to pay the claim if we use a defective car. So it behooves us to give proper inspection in that respect.

There are a great many hopper bottom cars loaded with coal leaving the mines that are in unfit condition, and a car has to carry the coal to its destination. I would like to emphasize the importance of close inspection at the coal mines. There is a cry for coal all over the continent as there never was before, but I think we can get better repairs to some of these cars than at the present time.

Since 1893 our average claims have increased from $30 to $55. The courts all the time are ruling in favor of claimants. Up to a few months ago we paid claims on the basis of invoice value at the place and time of shipment. We would make a man show his invoice, but now the courts have ruled that we have got to pay the claim on the basis of the value of the goods to destination of consignee. It has made a wonderful increase in our claim payments because we are not able to determine the value of goods at destination.

We have many cases where refrigerator cars containing fruit and other things of that kind are run over several different roads. The drip pipes are supposed to be clear. They are iced and when they get to destination, from the Pacific to the Atlantic, we frequently find that the drip pipes are clogged and the car will have a foot or two feet of water, the doors are open, and we have a claim to pay. Refrigerator cars are largely privately owned cars. Get better inspection to protect your own road and to protect your connection.

We have the same trouble in connection with the bunkers and different parts. Many of the employees did not know what the different parts of the refrigerator cars were and were not able to carry out the instructions. Now we have a monthly meeting and we have been instructing all employees and examining them as to their knowledge of the car, just as they are being examined for safety and other appliances.

The Grand Trunk has had in operation for some time a claims prevention campaign, and the results have exceeded our most sanguine expectations. Without going into details or quoting figures extensively, I would say that broadly speaking our claim payments due to defects in service of one kind and another have decreased by 50 per cent.

I mean of course a decrease as compared with the earned revenue. The actual amount would be more in our favor were it not for the fact that the high cost of the commodities operates against us. To achieve this result required the co-operation not only of our own staff, but also the staffs of other lines. The benefit of better methods of handling freight which will accrue to any one particular road as a result of their own endeavors will be negligible if other roads are not moving in the same direction. The great bulk of traffic moves in car load lots, and it will be easily seen that handling with the utmost care over portion of the route will be practically of no use if the car is negligently handled on the balance of the journey. The damage in evidence at destination will be what is known as "unlocated damage" and the claim if paid will be prorated on a mileage basis so that the careful carrier pays a prorata amount equally with the careless one.

This condition cannot be overcome. The remedy is for employees to handle cars as if their own company only was involved and they were individually responsible for the arrival of the shipment at destination in good shape.

In the proper apportionment of claims paid as between car-

riers the members of your association play a very important part. Especially is this the case in losses from open equipment. When loss has been established and the claim paid, the next question is whether the loss is a located one or an unlocated one. This gives rise to the query, "How did car check at the junction point?" The answer to that question will depend to a great extent on the thoroughness with which the inspector carried out his duties or rather to what extent he carried the inspection.

The principal losses from open car equipment are coal shortages and parts of machinery. As regards the latter, unless in very exceptional cases, a junction examination will scarcely be sufficiently minute to say with certainty whether loss occurred or not. Such shipments are usually described as a carload of machinery and the parts can be and frequently are removed in transit without anyone being the wiser till check is made by consignee when it is found parts are missing. These cases rarely present any difficulty, it being pretty generally agreed by all having any connection with the adjustment of claims that such losses are unlocated and where settlement must be made as a result of suit or otherwise such claims are usually prorated from shipping point to destination.

In the case of coal shortages, however, a different situation presents itself. Here we have a case where the whole matter is in the hands of the railroad employees. The car is scaled and a certificate furnished to the mine owner giving details of gross, tare and net weights. The car arrives at destination, the consignee is advised of arrival and demands the car be weighed before he accepts it. He gives as his reason for this demand that a previous car accepted by him in apparent good order was ten tons short. On weighing this car a similar shortage is discovered and the carrier delivering the car is presented with a claim for the value of the shortage. In fact various firms refuse to accept cars of coal till weighed and rely on weights so obtained to press claims for loss.

Such claims must be recognized as the legal departments of various roads have ruled unless it can be proven conclusively all the coal loaded at shipping point was delivered at destination, less allowances if any covered by tariff, carriers are liable. Where shortages of quantities up to say five tons occur in transit either as the result of robbery or rough handling causing part of the contents to fall off the car, or of leakage developing in transit and being stopped without record being made on the waybill it will be conceded without question such losses would not be noted in junction inspection.

The number of heavy claims covering shortages of coal principally from Pennsylvania points to destinations in Ontario induced this company to give special attention to the examination of cars received at Niagara Falls during the months of July and August 1920. As a result our records covering the 30 day period ending August 19 gave the following results:

From the L. V. we received 32 cars in which shortage existed of 176 tons. From the N. Y. C., 35 cars in which shortage existed of 170 tons. From the Erie, 9 cars in which shortage existed of 27 tons. A total of 76 cars representing 373 tons short.

Figuring the value of this coal conservatively at $14.00 per ton the loss represented $5,222.00 during one month.

We also receive coal from the D. & H. at Rouses Point. During 1919 shortages were noted for the entire year totalling 1,795 tons. Commencing Jan. 1, 1920, a more rigid inspection was put in force and the figures covering eight months since installing this new method shows a shortage detected of 3,753 tons. To obtain the best possible results from junction inspection we are convinced it is imperative that where any depression is noted in the load or where any evidence of leakage is evident the car or cars should be weighed as it is impossible for any examiner to give a reasonably safe estimate of the quantity missing. In fact we have had cases of shortage where the junction record showed overhead inspection made and no exceptions noted to either car or contents, yet a heavy shortage was disclosed as a result of weighing out at destination. As a result of direct enquiry to operating officials of the carrier on whose rails car originated we found the quantity claimed for, over 15 tons, was removed on their rails.

Cases of this kind of course are rare and the only inference to be derived from their occurring occasionally is that the party entrusted with the duty of inspecting cars did not in fact inspect them but merely made a book record to the effect everything was O. K.

These remarks are made not in any spirit of carping criticism but are offered in the broad spirit of betterment of the service. If they succeed in eliciting from this assembly suggestions tending to improve the claims situation or promote closer co-operation between the car inspectors and car foremen of the various roads at interest their purpose will have been achieved.

I am glad as a claim representative to meet you gentlemen. I want to say in closing that on Oriental oils we have had serious loss, and have considered the matter of preventing this loss to a large extent, but we do not seem to be getting anywhere. This oil comes in wooden barrels and in summer it seems to thin and leak. We are trying to classify it so that these cars should be iced during the summer. The shippers fought us so that we got the Interstate Commerce Commission interested.

President Gainey: I want to thank Mr. Arnold for his very instructive talk, which will be incorporated in our minutes.

W. P. Elliott: Why would oil be put in a different kind of car? The way bill would tell what that car carried previously.

E. Arnold: What I meant was, when you have to transfer a car of oil that is worth two or three dollars a gallon, try to get the same kind of a tank, and a car that is fit to hold it. On grain leakage last year the Grand Trunk paid $128,360. There were a great many cars used that were unfit for grain. Our claims have been reduced 50 per cent the present year over 1919, notwithstanding the heavy increase in the cost of all commodities, due to the efforts of the claim prevention committee.

T. J. O'Donnell: The losses that Mr. Arnold mentions are largely due to defective hoppers. For the past five years we not only used brown paper but we used logs to keep the coal in the cars. Out of 50 cars that were delivered there were 25 fixed up with boards and stakes to hold the coal in. We cannot transfer every car that is defective. The Grand Trunk goes the limit in fixing them up. We have inaugurated an inspection in the receiving yard by a Grand Trunk man. Our car inspectors in addition to the mechanical inspection, when they are up on the end of a car to look for brake appliances, must see if there is any depression of the load. They note the depth and take a record. While I would rather see the agent do it, the car man can do it with little or no delay. It ought to be done where open top equipment is used so extensively.

I want to introduce Mr. James Coleman, who is now assistant superintendent of motive power of the Grand Trunk.

Address of Mr. Coleman

I did not expect to be called upon to say anything to you today. I came here to listen and not to be heard, and I have been very enthusiastic over what I have heard here this morning. I believe this is a school of troubles in the car department. You are starting here a campaign to show to the railroads the shortcomings in the handling of their equipment,

also in the design and construction. It is true that the equipment has not been taken care of. The railways have not had an opportunity, but if the men in charge of the departments of the railroads could only sit in here this morning and listen to the intelligent criticism, and the defects that have been brought out by you this morning, it would be an education. I want to say to you frankly that the proceedings of your meetings, if they have all been on the same strain of this one here this morning, do not get publicity enough. It does not reach the heads of the departments. You men here know more about the defects and the reasons for them than the man who sits at a desk in an office and designs the equipment and tells you how to operate it. You will find the defects.

If a man in the car department wants to find the shortcomings of some particular design of a car, who does he go to? The car inspector. He is the man who finds the defects; he is the man who knows; he is the man the railroad pays to know, and if he did not qualify he would not hold the job.

I am going to advocate, all I possibly can, more publicity for your proceedings where they will reach the men who are responsible for the maintenance of the equipment, for the good criticism that you offer here will be an education to them, as I have stated before. I am glad to welcome you here and hope you will return to Montreal next year.

President Gainey: I am sure we all appreciate the very kind words of Mr. Coleman.

W. R. McMunn: All the gentlemen who have favored us with their presence have been thanked before, but I would like to suggest that the association extend to them a rising vote of thanks, to show that we appreciate their coming. (Carried unanimously.)

Thereupon the meeting adjourned.

Wednesday Afternoon Session

At the opening of the afternoon meeting M. J. O'Connor presented a paper on the Lubrication of Freight Equipment, with regard to obtaining maximum mileage and methods to be pursued to overcome hot box trouble. This paper, with the discussion will be published in the January issue.

REPAIRING CARS IN TRAIN YARDS

BY O. E. SITTERLY
Foreman Car Inspector, Pennsylvania System

I have been requested by our secretary to open a discussion on the best means of repairing cars in train yard for defects that can so be repaired to overcome setting cars on the repair track, especially loaded with high class freight such as meat, iced commodities, poultry and similar shipments.

I personally believe that there is no one present who has not the same subject in mind, knowing the real necessity of cutting down so many cars being crippled, which have to be switched out of trains and moved to repair tracks, and bearing in mind the serious delay to shipments, the liability of claims and the extraordinary expense in so handling.

We, as supervisors, have been hiding behind the transportation department and using this as a defense, claiming that the holding up of trains to make repairs in transportation yards is causing serious delay. However, my inquiries, as well as our practice on the Pennsylvania, have proved beyond a doubt that the delay in holding cars in outside yards for making repairs has overcome considerably the delay and expense of switching cars into shops, and we find that the transportation people are co-operating with us in our efforts to cut down the shopping of all classes of cars.

It has been so arranged that on our inbound trains the yardmaster will allow us to work on trains until such time as they are ready to handle the cars, thereby we have increased the number of cars repaired in the outside yard, which, as you can readily see, has decreased the number of crippled cars, delays and amount of expense in handling the cars to our shop tracks.

For your information, I am particularly referring to repairs such as brake beams, ladder treads, hand holds, adjustment of lading at doorway, applying journal bearings, etc.

I have every reason to believe that this discussion will bring out some very interesting information. Also I believe that during this discussion facts will be brought out or some recommendations made that will help us all to go back home and start a campaign in such a manner that it will be a surprise to our officials to note the large number of cars that are being repaired in the outside yards, thereby cutting down the shopping and holding up of so many cars.

It is a surprise to note the defects that cars are being shopped for at the present time. This is due to the lack of sufficient help in the outside yard. This also should be looked into with a view of reducing delays in making these repairs.

My experience in the outside yard for the past 22 years has proven to me, beyond a doubt, that there is considerable room for improvements along these lines, and I know that we have the timber amongst us today that can do considerable to help this along.

Discussion

W. P. Elliott: We do nothing in train yards except safety appliance repairs that can be made without the men going under the cars.

T. S. Cheadle: We have a man who makes repairs on perishable trains, as has been brought out in the paper. The practice is to put up a flag on the end of the train when the inspector makes his inspection and checks defects, and makes the repairs. At our Potomac yards we have a man who does not do any inspecting but passes on inspection, and makes the original record of repairs. At either yard we have a man who makes the repairs and the original record himself, and turns it in to the general car foreman to be made out on the A. R. A. billing repair card.

Mr. Smith: We have several places where we receive cars in the yard, and the inspector is not exempt from making repairs. He has to make a certain number of repairs, and then behind him comes the repair man who will make heavier repairs, such as cutting off a handhold or putting on a brakebeam. We have two men working together who follow up on heavy work. We do not exempt the inspector from making light repairs. We lock the track in addition to putting up a blue flag.

W. P. Elliott: How many follow the same practice of having inspectors make light repairs? Under the national agreement all of these men are classed as car men. The inspectors have claimed in some districts that they maintain the classification of car inspector if they do not have to make repairs. We say the car men are only entitled to the distinction that he is assigned to. It does not relieve him from any work that he is assigned to do. Do you ask car inspectors to make light repairs?

President Gainey: We ask all of our inspectors to make repairs. Three or four months ago I was at one point on our road and that subject came up, whether a car inspector had to do the work and their own inspecting. The sentiment on our system was at that point that they did. While their classification on the pay roll was inspector, it is done so that the man at the head of the department will know where his men are, but he says "A car man is a car man, no matter where he is put; if he hasn't got repairing to do he must help out with the inspecting and vice versa." That is what we are following out.

T. S. Cheadle: We are carrying that on now without any exceptions being taken to it.

W. P. Elliott: Our men say they are not supposed to do it. I maintain that a car man is a car man. If it is a question of doing autogenous welding, or something like that, it is different.

President Gainey: We take two inspectors, one light repair man and one oiler to go over a train; two inspectors go over the train and a light repair man follows. If an inspector gets to the end of the cut, he doubles back and makes the repairs until he meets the light repair man.

T. J. O'Donnell: I believe that we are overcoming the switching of light repair cars to the repair track. We have six or eight meat trains between midnight and morning. You all know what it means if you cut out five or six cars to the repair track. The D. L. & W. will hold a train while they are going through and oiling and repairing at East Buffalo. They have five or six follow-up yard repairers. I maintain that two or three men following up the inspectors on a meat train is an excellent practice, because if a meat car is set out to a repair track it not only loses the train, but the next train is 12 hours away, and when you hold it that long it means 26 or 28 hours in the terminal, because the operating department cannot handle it, and the result is that we get a claim.

R. Barnaby (D. L. & W.): In East Buffalo we have two air inspectors and two followers-up and an oiler on a train. After a train is completed by the yard department we lock both ends of the switch with a blue flag on each end. On live poultry or meat cars we apply brake shoes in the train and do all that class of work. We generally use 40 minutes or an hour on a train of 45 to 50 cars. We do everything we possibly can to keep these cars in transit.

W. P. Elliott: I believe that is the practice pretty generally to put the flag at both ends. We get a certain amount of time not only on live stock trains but on dead freight.

A. Berg: I think it is general throughout the country. I know it is mandatory with many of the railroads. We will tolerate a fellow remaining idle a few hours rather than tie up a train.

President Gainey: In some yards you cannot do that where you have 25 or 30 tracks and they are continuously switching and classifying. You can even put draft bolts in if it is an empty train.

T. J. O'Donnell: We put draft bolts in a hog train.

W. P. Elliott: You can do a lot of that work by co-operating with the yard department. In classification it is different, and if you have a car going to the repair track, it doesn't make any difference. You cannot do work on that class of trains. It is out of the question.

T. S. Cheadle: The freight houses in our territory are taken care of the same way. They have one or more men to look after the light repairs. These men are inspector and repairer and classed as such.

A Member: What is the general practice of having the material on hand for making the light repairs, and what is followed out in most yards from a safety standpoint?

T. S. Cheadle: We have a pen that we put the material in. If they have to have a brakebeam they go get one. The men go every day and fill up the pen with the pieces that are lacking in the stock that is put there. Provision is made that this can be charged out to train yard repairs.

President Gainey: In a great many yards the material is kept in about the center of the yard or some in the center and some at both ends where the men can get it readily.

A Member: At West Albany, on air brake inspection on the receiving track where there is one movement one way and another movement the other way, and also classification in the yard, we have a difficult problem. At one time we tried to test our trains on the receiving track with the engineer's valve. It was surprising to see the number of defective brakes found on the trains on receipt. We try to put in cylinder gaskets, test the triple valves and change triple valves, and get the trains in pretty good condition on the receiving track. We had quite a big yard and found there were so many defective brakes and it delayed cars so long that we had to stop it. We tried carding and found that we needed a shop track of 5,000 cars to make the percentage and bring it up to the required 85 and over.

We have what is known as hand brake tests; one man working on top and two on the ground. These men are followed by running repair men. We have had 10 or 15 brake cylinders to take down in a train of 65 cars. I wonder if anybody else is doing that or what their method is.

R. Barnaby: We have three men on each shift. They change triples and clean cylinders on all trains after the trains are made up.

Mr. Smith: We do not do any of the work of adjusting and cleaning brakes in the receiving yard. The cars are repaired there except the brakes, and they are humped over into the classified yard. They have enough men down there and do not call the crew until they know the train is ready. All trains are made up and called one hour before they go. It does not mean that we could only despatch one train an hour; you would have to have two or three gangs, the train would be ready an hour before being called to leave.

T. S. Cheadle: I think we should all read the discussion on this by the Air Brake Association and do the best we can with it.

F. W. Trapnell: I move that the paper be received and spread upon our minutes, and a vote of thanks extended to the man who wrote it and to Mr. Barnaby who read it. (Seconded and carried.)

T. J. O'Donnell: I am going to appeal to all our members to try to get more new members. I asked Mr. Keene at noon how many he had and he said about 40. We came up here with the firm idea that we could get 150. If you brush up against anybody who is not a member, I think we ought to get after them.

Thursday Morning Session

As soon as President Gainey called the meeting to order the discussion of the selection of the place for the next convention was taken up.

T. J. O'Donnell: I really think the time has arrived when we ought to consider one central city as the meeting place of this association. We have practically covered the section east of the Mississippi River, and I would like to have our Executive Committee consider the city of Chicago as the meeting place of our association in the future.

W. J. Stoll: That city has been my choice not only now but in the past. I think Chicago should be made a permanent meeting place on account of hotel accommodations there as well as trains. The Sherman Hotel is equipped with air and electricity for power that the supply men may use for running machinery if they want to, and it would increase our membership perhaps 100 per cent.

F. W. Trapnell: I think the proper method would be to read the invitations. When I was president I favored one meeting place.

President Gainey: I am in favor of a regular meeting place, and I would like to see the members of this association this morning vote to make Chicago our permanent meeting place and let the Executive Committee set the dates of meeting. The by-laws should be changed so that one meeting place could be designated.

F. W. Trapnell: You cannot change the by-laws now.

W. J. Stoll: I believe the Executive Committee should have full power to act.

Wm. P. Elliott: I do not believe it is right to give the Executive Committee full power. They assumed power last year that did not belong to them.

T. J. O'Donnell: I move you that this assemblage recommend that this convention has come to the conclusion

that it would be for our best interests that all future gatherings of this body be held in one central city, and that the association, knowing the location and convenience, select the city of Chicago for our meetings in the future and that arrangements be made accordingly by our Executive Committee. (Seconded.)

J. C. Keene: We have a small attendance here this morning, and I think it would be well to let the Executive Committee decide.

T. S. Cheadle: It seems to me it would be no more than right to put that up to the members now.

(The question was put upon the motion and carried.)

Two papers on A. R. A. billing were then presented.

REPORT OF COMMITTEE ON A. R. A. BILLING

In order to provide the most essential requirements for A. R. A. billing, the building up of an efficient force of car inspectors and repairmen is necessary. The duties of these are to report work on cars under A. R. A. rules. The shop force, such as car foremen, car inspectors and repairmen, is the only foundation from which an efficient organization can be built, and when properly coached by some one in intimate touch with all phases of the work, the billing department will be one of the best and most efficient departments in the railroad service.

The fact that should be impressed on the shop men as well as the A. R. A. clerks is that every item of repairs should be shown on the original record, and all items should be thoroughly checked against the work performed, to see that no repairs are shown on the original record that were not actually made. This will ensure foreign lines being billed only for work actually performed, and will also ensure the handling road being reimbursed for its work.

There was, during federal control, more or less disorganization of the A. R. A. forces, which had been built up by years of training men for this class of work, and I doubt if there is a railroad in this country that is getting the efficiency they should get in the A. R. A. billing department at present. This condition results in a considerable amount of incorrect billing and causes a large amount of controversy and needless correspondence, which an efficient organization will avoid.

In our experience we have found the average shopman ready and willing to learn when an opportunity was afforded him, but, unless the importance of keeping in close touch with the rules and various changes from year to year is occasionally brought to his attention, he is liable to overlook some very important item.

The first thing that should be done when an inspector, car repairer or A. R. A. clerk is put to work, is to give him an A. R. A. book of rules to be studied. His superior should discuss the rules with him thoroughly until he is satisfied that the man is familiar not only with the rules, but that he understands their interpretation and application correctly. The A. R. A. clerk should visit the repair tracks, where the original record is compiled, as often as conditions will permit, and check the work on the car with this record, so that he may have an opportunity to familiarize himself with the work and various kinds of material used in making repairs to cars. This will enable him to check more closely the original record as turned in by the repairmen, and detect errors that might otherwise be written into the repair cards, causing them to be returned for correction, resulting in unnecessary work and delay.

For instance, if a repairman in applying a pair of steel wheels to a car would through lack of familiarity with correct billing practice fail to report the amount of service metal on wheels removed and applied, the clerk handling the repair card for the same reason would write up the repair card, leaving this information off, and forward the card to the billing department which would have to return it for proper information, with the result that the car having gone back into service and the wheels removed disposed of, any report made would necessarily be fictitious.

Also in applying journal brasses, if the box location were omitted and the following information not given on the original record:

Coupler applied, not showing whether key or yoke attachment or size: also if A. R. A. type *D* applied not shown.

Number of brake beam removed or applied.

When applying center sill or center sill splices, showing all bolts and other items necessary to complete the work: also if center sills are spliced, whether first application of splice boards, so that all bolts used will be charged at gross weight.

In applying one draft timber, if draft bolts were used other than were used in the draft timber applied, and were just shown as draft bolts, not showing how many were used in the opposite timber, would result in incorrect information.

We have just cited a few of the many, almost thousands, of discrepancies with which we have to deal almost daily.

Every effort should be made to have these reports accurate, as to fall into the practice of estimating is bound to result in fictitious information, and tends to create the impression that correct and accurate reports are not necessary, and would have the effect of introducing carelessness and indifference into clerical work, as well as loss of interest at the shops.

The report is signed by J. A. Roberts (C. & O.), chairman, and Allen Foster (N. Y. C.).

INDIVIDUAL PAPER ON A. R. A. BILLING

BY C. C. STONE
Southern Railway

The subject of the preparation of original record, billing repair cards and A. R. A. bills, is a big and important one in which all carmen are vitally interested, in that it is the only item or resource from which the motive power department of the railroads may secure a credit to their accounts and thereby reduce operating expenses, which the officials are so often called upon to explain.

The matter of records is of vast importance in supporting charges for repairs. The rules require that the original record, whether in loose leaf, card board or book form, be complete and that no information be assumed. The Arbitration Committee has always based its decisions on the records, and the A. R. A. Section III—Mechanical has gone far in the past few years in adopting standard forms with a view to obtaining uniform records in all railroads. The average mechanical man who repairs cars and also takes record of same, more or less depreciate records, and we feel that their importance should be impressed upon all concerned for the preparation of billing repair cards and A. R. A. bills, keeping in mind the principle of honesty advocated by the American Railway Association and the necessity to show the true condition at all times.

The A. R. A. rules require that billing repair cards must check with the original record of repairs, as regards the detail of charges, and that the common terms bent, broken, and missing, if used when caused by derailment, cornering or sideswiping or other causes shown in Rule 32, must qualify to show such cause, as authority for endorsing billing repair cards "No Bill."

The rules require that a billing repair card must be furnished the car owner for any repairs made to all cars. The average car department employee is under the impression that when repairs are made to a foreign car that will not be properly chargeable to the car owner, no billing repair card is to be furnished the car owner; this is entirely wrong, for the car owner desires to know at all times the repairs made and whether the repairs are proper or improper.

The preparation of original records, billing repair cards and A. R. A. bills, which involves a mass of detail work.

is largely a routine matter and we feel that the most important factor is the preparation of billing repair cards, the foundation on which the A. R. A. bills are rendered.

The car department employee should learn to term the material used in making repairs, as they are termed in the A. R. A. rules, for the benefit of employees who are not practical car repairers, whose duties are the preparation of billing repair cards.

A good deal of trouble is being experienced in not giving correct car initials, numbers and dates.

The A. R. A. rules stipulate the charges to be made for nearly all items of repairs to cars, and I would suggest to those making up billing repair cards and A. R. A. bills, that if they will keep before them the spirit or intentions of the A. R. A. rules in applying the labor charges shown in Rule 107, and which spirit or intention is shown all through the rule, it would greatly assist in eliminating if not practically doing away with the difference of opinion as to the proper method of applying such labor charges.

For this reason we wish to call your attention to the importance of an efficient organization in the car department; and to point out the duties of each as relating to this work and to show the necessity of systematic instructions in keeping all concerned thoroughly acquainted with the rules at all times.

We believe that meetings should be held upon receipt of a new rule book each year, also on receipt of supplements received from time to time, and that free exchange of views, where matters are argued from all points, is the most efficient manner in which matters of importance can be impressed upon the minds of those concerned, with a view of establishing a uniform understanding of the A. R. A. rules.

The position of car foreman is one of the most important in the operating department, and requires a man of sound judgment. He is required to repair equipment of all classes and design and maintain standards without blue print instructions. He is responsible for inspection in interchange and transportation yards and is required to pass judgment on the safety of equipment and in fact he is the versatile man of the railroad to whom all operating officials turn when anything special is anticipated. Car foremen should be thoroughly acquainted with the A. R. A. rules of interchange and billing that they will be familiar with the actual value of labor and material and thus protect the financial interests of the railroad company by which they are employed.

The position of A. R. A. billing clerk is very valuable in assisting the car foreman. The clerks should be picked from the car repair force when available, they should have a fair education and write a legible hand, and with the practical knowledge of construction of cars the task of the application of the A. R. A. rules will be much easier in the preparation of billing repair cards.

With the interchange inspector rests the responsibility of protecting the railroad company from receiving equipment with handling line defects, to see that standards are maintained, and that cars are in a safe and serviceable condition, and that no safety appliance defects exist, as required by law, and that all handling line defects are properly carded. Many interchange inspectors are located at insolated places and unless some special efforts are made to keep them posted in the application of the A. R. A. rules, they will naturally feel that their positions are of little importance and become lax. Keep the inspectors enthusiastic by calling on them occasionally, impress upon them the importance of keeping records in protecting the company's financial interests, subject them to periodical examination on the A. R. A. rules and their ability to determine proper names of various defects. Special attention should be called to the importance of showing all necessary information required by the A. R. A. rules for repairs made, on the original record and billing repair cards.

Special attention of car inspectors is called to the importance of closely inspecting all cars received from foreign lines and of requiring defect cards for all "cardable" defects discovered. It is also important that special attention be given to inspection of all cars for safety appliance penalty defects.

It not infrequently happens that an inspector, not being familiar with the A. R. A. rules, will place a defect card on a foreign car to cover an owner's defect. This is a serious mistake because under the A. R. A. rules the issuance of such a card under such circumstances makes the line issuing the card responsible for labor and material, whereas, if the card were not issued, the owner would be responsible. Great care should therefore be used by inspectors in issuing defect cards to prevent errors of this kind.

It also happens that some interchange inspectors will receive a foreign car with a handling line defect, and run the car on book record, not taking in consideration that the same car when offered at some other interchange point on the line of road will have the defects carded, thus penalizing the handling line for not having car properly carded when received at some other interchange.

Remember that a defect card is authority to bill for labor and material necessary to complete the items shown thereon and is a check against the railroad issuing same.

Defect cards should specify that all damage occurred to *A* or *B* end, right or left side, which will give bill clerk a fair conception of the damages and enable him to check overlapping labor.

The successful rendition of A. R. A. bills also requires an efficient organization thoroughly familiar with the A. R. A. rules, interpretations and arbitration decisions and in view of the importance of this work, in that they are handling the equivalent to cash money, special attention should be given to the training of bill checkers.

To successfully price billing repair cards, it is necessary that bill clerks secure a general knowledge of the physical construction of cars, which can only be obtained by practical experience or observation.

Clerks whose duties are the preparation of billing repair cards, located at or near repair tracks, who have not had practical experience, should take every opportunity to avail themselves of the physical construction of cars from observation, thus enabling them to properly prepare billing repair cards.

The handling of A. R. A. bills on the Southern Railway System is a joint arrangement between the motive power and auditing department. The motive power forces prepare the billing repair cards as to repairs made and reason for same, showing kind of material, weight of material and labor hours, the auditing force, checks the weights, labor hours, inserts all net charges and totals up repair cards, seeing that all information as required by the A. R. A. is properly shown. These repair cards are forwarded from the master mechanic's office to the auditor of disbursements' office weekly on form 1043, showing the number of repair cards forwarded. After record has been made of repair cards received, they are then passed to bill checkers for pricing. Any repair cards not properly prepared are returned to the originating station, with a notation pointing out the additional information required and calling attention to the specific rule which governs. After pricing, the repair cards are assorted as to owners and passed to the bill writers. For writing bills we use billing machines.

The auditing forces also check and voucher foreign bills; the checking is done by separate forces, one force checks and prepares bills against foreign railroads, and the other checks foreign railroad bills against the Southern Railway System. The forces are continually comparing charges, all disagreements are decided by the chief A. R. A. clerk.

The accounting department has a force of special traveling auditors, assigned to A. R. A. work. They are to visit all

shops and inspection points and confer with officers and employees having to do with making repairs to cars, and issuance of A. R. A. billing repair cards, defect cards, and trainmen's report of repairs made. Special attention is given by them to explaining and interpreting the practical application of A. R. A. rules to work done by car inspectors, and others. All officers and employees are earnestly requested to give them their hearty co-operation and support.

Their duties are both instructive and constructive, instructive in that they are required to teach the A.R.A. clerks, inspectors and repairmen the fine points of the work and explain the application of A. R. A. rules in billing, constructive in that they are required to suggest changes in methods or organization to best safeguard the company's interest.

Supplement No. 3, effective Sept. 1, 1920, on account of changes in labor hours and net material charges, and additional items, requires careful study to properly prepare billing repair cards and A. R. A. bills.

Discussion

On motion the reports were received and ordered spread upon the minutes of the association.

T. J. O'Donnell: One thought occurs to me and that is that the heavy responsibility that falls upon these accounting clerks would justify a change in their title. They should be classed as shop inspectors, or shop accountants. The word "clerk" does not appeal to me. I think also there should be an outside man working in harmony with the general foreman.

W. R. Morris (A. B. & A.): I have exclusive charge of A. R. A. billing repair cards. The greatest fault among inspectors is the different names we have given parts of repairs. If they would adhere to the rule in writing up the repairs, it would save much trouble. Some fellow will write spring bolster by three or four different names, and a lot of them are not familiar with the proper terms. I stayed five years on the repair track before I went in the office. In the past two weeks before I came to the convention I checked $35,000 worth of bills against us. I found technical errors due to the inspector or foreman not showing conductors putting in brass and air hose. I did not write a letter because the system used on our line is to furnish all points and train crews with new brass and air hose. If the man fails to put this in, one man cannot handle it.

As for the bill clerks, I would like to have the gentlemen here go into that and tell them not to take exceptions to technical errors such as new air hose and brass applied. We are using a re-filled or re-lining brass and standard air hose and I would like to ask each of the foremen here to ask their bill clerks personally, when they take exceptions to a bill, to know that they are right and not take exceptions to a technical error that some bill clerk has overlooked.

T. S. Cheadle: It seems to me that we get the highest efficiency in this work and we should have a technical understanding of terms. It is very tedious for bill clerks. The same thing is true of sheathing on ends; on sides it is siding.

The committee appointed to consider the maintenance of passenger cars did not submit a report, but an individual paper prepared by the chairman, J. R. Schrader, was read by C. S. Adams.

PASSENGER CAR MAINTENANCE

BY J. R. SCHRADER
District General Car Foreman, New York Central

This is a very broad subject and one which requires considerable attention. After equipment is received from manufacturer, or after general shopping, it should be, and generally is, in first class condition. Therefore, it is important, in order to maintain this equipment in first class condition, that it receive careful inspection at each terminal and that all necessary repairs are made. If small defects are not repaired it may not be long before the car has to be cut out of service and shopped.

In order to obtain the best results there should be a system enforced at points where this class of work is done. The condition existing at each point, of course, has to govern the organization of such a system. At terminals where equipment lays over, trucks should be examined, all bolts tightened up, all worn parts which require renewing changed, brake connections and rigging keyed and bolted and cars inspected in general on the exterior and the interior for any defects, and proper repairs made.

Lubrication being one of the important items, journal box packing, brasses and wedges should be examined on arrival at terminals and given proper attention. Good results can be obtained by having a book of instructions for the lubrication and care of journal boxes.

The axle lighting system should receive careful inspection and proper repairs, and also be governed by a book of instructions for the maintenance of electric car lighting equipment.

Air Brake Maintenance

At terminals and repair tracks proper inspection must be made, and this can only be done by the use of a testing outfit, either stationary or on a truck. As the application and release of brakes are the two most important factors, it is essential that the rate of brake pipe reduction (to apply) and the rate of increase of brake pipe pressure (to release) be made as near as possible to actual operating conditions in order to determine that equipment will operate in a satisfactory manner when the car is placed in any location in a train, and the above cannot be accomplished if a too rapid reduction, or increase, is made. As for instance, the use of the angle cock, to apply, and the opening of the angle cock to which a yard hose is attached, for release, should not be considered as a test for the reasons given above.

At shops and repair tracks when triple and control valves are removed for cleaning and repairs, special attention should be given dirt collectors and strainers, as they perform an important part in keeping foreign matter from the valve mechanism.

The automatic slack adjuster when cleaned should be tested for leakage both in the piping and its cylinder. The brake cylinder piston travel should be let out beyond eight inches to ascertain if the adjuster is in proper working order. Oil or grease should not be used on the slack adjuster screw.

On cars equipped with P. C. equipment and automatic slack adjusters it is not only important that the travel of both the service and emergency brake cylinders be adjusted equal but it is also necessary to know that the service cylinder adjuster is in operating condition; as inoperation of this adjuster is very likely to result in tight brakes.

When brake cylinders are cleaned, a wooden paddle, the edges of which have been rounded, should be used in placing the packing leather in place in the cylinder. Many packing leathers are ruined by using chisels, or such tools as file shanks, or iron scrapers. The amount of lubricant used should be measured for each size of cylinder, not guessed at. The exact quantity of lubricant should be determined by a set of tin measures furnished, each measure stamped so the cleaner can know the proper amount allowed for each cylinder. An excessive amount of lubricant in brake cylinders is not only wasteful, but is liable to be forced into the triple valve mechanism, thus causing improper operation of the brakes.

The work mentioned above should only be done where proper air pressure is available, for to make repairs without making proper tests after equipment is applied to the car is out of the question.

All triple and control valves when cleaned should pass the prescribed tests for such valves before they are allowed in

service. This should also apply to new valves received as spares or on new cars.

The tests can best be made and better results had if valves are not lubricated before being tested, as in this manner worn bushings and poorly fitting packing rings can be detected; while, if lubricant is used, especially heavy oil or grease, the valve may pass the test O. K. and in a very short time fail in service. As the cost of cleaning and testing air brake equipment is no small item at the present time, we cannot be too particular in regard to the kind of repairs and efficiency of tests made in the air brake room. I might also add that past experience with lubrication of triple and control valves shows that the less used the better results will be had. Only dry graphite should be used on the slide valves and seats and then the quantity allowed to remain on the parts should be so small that it cannot be seen.

The improved method of testing triple and control valves devised by the Westinghouse Air Brake Company will give better results and all older types of test racks should be modified to the new, as the new method of testing for packing ring leakage and friction is far above the old.

The question of removing equipment from the car and sending to the air brake room for testing and cleaning on account of slid flat wheels, in the majority of cases is unnecessary, as the equipment can be properly tested by the use of a yard test truck, and when any equipment fails to pass such test it should be removed.

Weather and track conditions are responsible for more slid flat wheels than defective air brake equipment.

Car should receive proper cleaning on arrival at terminals and should be handled in a systematic manner and the interior as well as the exterior of the car should be well cleaned. The best result from this cleaning can be obtained by instructions on the proper method of cleaning cars at terminals, these instructions going into all details such as, general cleaning, interior cleaning, exterior cleaning and economy in material, and the workmen should be governed by the book instructions on cleaning.

Roofs of cars should receive regular inspection and be repainted when found necessary; floors, platforms and steps, and all iron work which has become rusted should receive same attention.

Shopping of Cars for General Repairs

General repairs to a passenger car is divided into three classes of repairs, viz.: A, B and C, which class of repairs denotes the paint operations only, and are explained as follows:—

Class A repairs covers the removal of all paint and varnish from the exterior of a wood car by burning, and a steel car by sand blasting, or when all sheathing or plates have been renewed.

Class B repairs covers the removal of all paint and varnish where necessary on a wood car exterior, painting the car complete, re-lettering and numbering.

Class C repairs covers the painting of the exterior, cutting around lettering and numbers, thus eliminating the additional expense of re-lettering and numbering.

When a passenger car arrives at the shops for general overhauling it follows the routine as designated.

1. *Inspection and Classification of Repairs.*—The receiving Inspector keeps a record of all cars arriving at the shop, and makes a daily report to the superintendent of shops. He records the number of the car, class, type, lighting, and any noticeable or carded defects. If the car is in a condition for general repairs, he shops the car for classified repairs, A, B, or C, noting any additions or betterments required. A "Bulletin Board," in the inspector's office, is maintained, showing the cars shopped daily.

2. *Stripping the Car.*—The foreman of the strippers notes the cars shopped daily and operations are started wherever the car is located in the yard. The stripped cars are spotted, and delivered to the wash shop via electric transfer table. All material is removed from the car and delivered to the various repair departments for cleaning, inspection and repairs.

3. *Wash Shop Work.*—When all material has been removed from the car, the interior is scrubbed, pipes scraped, if necessary, and the exterior is burned off or washed according to the class of repairs. Steel cars for sand blasting are delivered direct to the sand blasting room prior to entry in the wash shop.

4. *Repair Shop Work.*—When the car has been finished in the wash shop, it is then delivered to the repair shop, jacked up, placed on horses and the trucks removed for their repairs. After the car has been jacked up and trucks are removed, the car is given a careful inspection, defects noted and card attached to car, showing repairs, changes, etc., to be made.

During the course of repairs, the air, steam and water are tested and repairs made. Roofs are examined and repaired. Electrical work on car is also repaired. New wood applied, or plates renewed, is primed while the car is in the repair shops, thus saving time on the arrival of the car in the paint shop.

A bulletin board is maintained in the repair shop showing date in shop and date the car is due to be delivered to the paint shop, also all other parts removed by the strippers must move forward to the painters on the same day the car is delivered.

5. *Car Delivered to Paint Shop.*—When the car arrives in the paint shop, the car is inspected and a delivery date is forwarded to the delivering inspector, who makes a daily report, of cars to be delivered, to the superintendent of shops, who, in turn, notifies the superintendent of passenger transportation, when the car will be ready for service.

A bulletin board is maintained in the paint shop showing the dates cars will be ready for trimming, and all material removed must be ready for application.

When the painters have completed their work, the car is turned over to the trimming department, who trim the cars before they leave the paint shop.

6. *Final Inspection.*—The car is then taken out of the paint shop, placed on scales, weighed, measured for height and is then placed on the inspection and testing track.

Air, steam, water and electrical systems are tested, and the brakes and car adjusted. Final inspection is then made by the delivery inspector, and when all adjustments have been made the transportation department is notified that the car is O. K. for service.

(On motion the paper was received and ordered spread upon the minutes.)

A paper on the subject of lubrication by J. C. Stewart, foreman freight car inspectors, Cincinnati, Indianapolis & Western, was then read.

LUBRICATION REQUIRES ATTENTION

BY J. C. STEWART (C. I. & W.)

While I know that the interchange rules and car department work and duties will, as usual, be ably and efficiently discussed and handled from every angle during this convention, I have one great handicap in particular in mind, namely, hot boxes. I desire to suggest that the association arrange some means of urging and encouraging all the railroads to start a "more efficient understanding and service drive" along the lines of the care of the journal box.

We know that hot boxes are always caused by excessive friction, and that a vast amount of instruction as to the best method of handling lubrication, etc., has been issued from time to time. Notwithstanding this there still remains a great deal to be done before conditions will be as good as desired. While I am not in a position to state, neither do I

believe, that there is lack of efficient service in this line on all railroads; however, I do know that the majority of railroads have cars running throughout the country with such equipment in poor condition.

In many cases we find car oilers, box packers and even car inspectors who do not have the proper knowledge of the many causes of hot boxes, which cause a multitude of troubles and costs. All these troubles are caused by two conditions; either defective lubrication or excessive bearing pressure. However, we are aware that there are many details connected with the insufficient lubrication or excessive bearing pressure area, and, in order to get the proper results, all employees should know how and why they are caused. Unless they are familiarized with and we remedy these causes, we cannot successfully attempt to overcome or remove them.

Apparently, in many cases, authorities do not act in close enough relationship with these matters, thereby not following up and urging better conditions and attention. As, for instance: sending employees out along the divisions daily to repair hot boxes on cars set out of trains, and not keeping a record and check of the causes, etc.

There are many causes for the hot box situation that can be made readily remedial. I believe that the association through the officers or a committee could, by going in detail and following up these conditions, advocating better service to all railroads through correspondence, do a great service. I feel all officials and supervisors will consider that our best and most consistent friends are those who tell us of our faults, and they will thereby impress upon the minds of employees that if we want knowledge, like anything else, we must toil for it, and that the price of success in any line is not too great to pay. For the fit man, with no apology up his sleeve, is always admired.

On motion duly carried both papers were received and the subject carried over for next year, with the suggestion that a paper be prepared by M. J. O'Connor and the same committee continued. F. W. Trapnell then read the report on uniform inspection blanks.

REPORT OF COMMITTEE ON UNIFORM INSPECTION BLANKS

This committee was appointed at the annual meeting of the association held at St. Louis to look into the matter of a uniform inspection blank to be recommended to the Arbitration Committee of Mechanical Section III for their consideration and adoption, if in the opinion of this committee it would be necessary.

I have written all the interchange points of any particular note and secured samples that were being used at various points. We find all kinds of forms and some points with merely a book record. The book could easily be misplaced and the record of the car entirely lost. After considering the various forms submitted the chairman of the committee with A. Kipp recommend that the blank form shown herewith as Fig. 1 be used for points where the inspector merely takes the physical or mechanical conditions of the car, but at points where the inspectors, working under a bureau, take the records for the transportation department in addition to the mechanical department, we recommend that the form shown in Fig. 2 be used.

A. B. C. RAILROAD

DAILY REPORT OF CARS INSPECTED

Time .... Date .... 19....

From .... To ....

Fig. 1—Form for Recording Physical Condition of Cars

The card for bad order safety appliances, should be printed on both sides as in Fig. 3, showing on one side where safety appliances have penalty defects and must go to the repair track for repairs and the other side showing safety appliances with penalty defects but light repairs that can be made in the yards by the light repair men.

Fig. 3—Card for Bad Order Safety Appliances

THE KANSAS CITY CAR INTERCHANGE BUREAU KANSAS CITY, MO.

From .... Ry. to .... Ry.

INSPECTOR'S NAME	Sheet No.	MONTH	DAY	YEAR
				191

INITIALS	KIND	NUMBER Loaded	NUMBER Empty	Hour Interchanged	Destination or Consignee	Contents	SEALS Right Door	SEALS Left Door	CONDITION OF CAR

In "Kind" of Car Column use B for Box. S Stock. C Coal. F Flat. R Refrigerator. T Tank. Fn. Furniture

Fig. 2—Form to Be Used When Inspector Records Both Seal Record and Physical Condition of Cars

The committee is in receipt of a communication from T. J. O'Donnell, stating that at Buffalo there are two lines only having a form for handling their cars in interchange, the balance using a book.

Those are the only two members of the committee that I have heard from but I would recommend that the matter be

discussed and if in the opinion of the association such blanks should be recommended to the A. R. A., I believe that we will be making a move in the right direction as the Mechanical Section III from time to time has been simplifying and getting uniform rules and regulations, uniform cards for handling the business and a uniform blank would be not out of place so that the records could always be taken care of at a very little expense, a great deal less expense than by using a book record.

Discussion

After reading the report Mr. Trapnell said: The need for a uniform inspection blank was brought out by a freight claim agent of the Canadian Pacific who stated that without a proper record of a car at the initial loading point, the road loading the car would have to assume all of the responsibility for loss to that car. I have before me the blanks of the various interchange points throughout the country and I find that they are badly mixed up. Some have none; some have a blank piece of paper, without any heading, to be torn out of a book. These are easily misplaced unless a file is provided to keep them in.

The chairman of the committee corresponded with each point and after assembling the blanks and picking out the various kinds, each member of the committee having a copy of the blanks used by other points, the chairman took it up with all members, recommending a certain blank. I have a favorable reply from one member of the committee, Mr. O'Donnell, but he does not give his sanction of a uniform blank.

(A motion was made that the report be accepted and the matter referred to the Executive Committee for their handling at the February meeting and report at the next meeting.)

T. J. O'Donnell: My recommendation was on personal talks of our 150 car inspectors. They seem to all favor the book in bad weather. If you make out a blank statement today and file it in the office of the chief interchange inspector or a foreman is there any reason why an inspector, if he wants to make a false record, cannot get that blank and replace it with another blank? You fill the book from beginning to end. All you can do with that is simply to erase it. That was my reason for not voting affirmatively for the blanks. It seems to me, if you have the books properly filed, they will serve the purpose much better than the blanks.

W. J. Stoll: The form that is being used in our city is sent in by the inspector at the end of the day. One copy is filed in the chief interchange office and a copy of it is kept is his possession, or in the possession of the general foreman for him. The hard copy is sent to the interchange office and no inspector or anybody else can get in there without a key.

F. W. Trapnell: We use a blank and the inspector makes five copies of that inspection: one for the receiving line, one for the delivery line, one for the receiving agent, one for the delivering agent and one for the I. C. C. In that way we save an enormous lot of work by furnishing the agent the physical condition of the car when it is received, and when he gets his claim back he has the condition of that car.

T. J. O'Donnell: I favor the agent having a record. It saves a lot of correspondence. It would overcome 3,000 claims a month coming to our office.

President Gainey: We do the same as Mr. Trapnell, except that we do not give the agent a copy. The inspector takes the numbers and initials of the cars in his book. On those that are defective he notes the defects. After going through the cut, he takes the record to the shanty and writes three copies on a form: one to the delivering line, one to the foreman of the receiving line and one to the I. C. C. His own record is his book record.

W. M. Herring: We tried to get up some kind of a sheet instead of the five by nine book. Some claim they can carry a book in their pocket much handier than the sheet. We continued the book on account of the objections to carbon, and the disadvantage of carrying our sheets either in pad form or any other form.

President Gainey: That has been the general objection. Kansas City is about the only one that has used the loose leaf form.

M. W. Halbert: We tried the book record several years ago and now we use the sheet. The inspector writes the original record and takes a copy. The original he sends to the chief inspector's office, and the duplicate is sent to the foreman of the delivering line. We never have any trouble.

W. P. Elliott: In our district we take two and three copies of the record. I do not approve of making six copies of the record. Mr. O'Donnell is right; to put carbon in between four sheets of paper in rain or snow you have a job. I approve the loose leaf idea. It gives a better filing system in the office. I do not think it is a good idea from a practical standpoint to furnish the agent a copy of that record, because they have all of these records in their own office and I am satisfied there is less expense when we furnish them than in furnishing to all of the agents. If you put another man in the office it would be cheaper if you figure the time the inspector consumes in doing this extra work.

E. H. Mattingley: I want to agree with what Mr. Elliott has said. I think the car inspector today has all he can do without making five carbon copies of his records as to the condition of a car in interchange. If he will carry out the inspection according to the rules, take care of running repairs on defect cards, he has about all any man wants to do. We have joint bureaus at the large terminals and they get the original record at the time the car is inspected. If anybody else wants it, why not get it from that office?

F. W. Trapnell: I did not recommend that in the report. I simply said we did that. I do not care how many copies you have, but the idea that Mr. Mattingley laid down is not a correct one to place before this convention. The inspector makes five records with one scratch of the pencil. The car inspector is not so loaded down with work. The carbon is changed in the twinkling of an eye.

W. P. Elliott: I agree with Mr. Mattingley and disagree with Mr. Trapnell. The most disagreeable thing a car inspector has to do today is to change the carbon. I know whereof I speak. Many a time I have written my records on a bad night and found that I had the carbon upside down.

T. S. Cheadle: I know from experience that the form as recommended by Mr. Trapnell can be used, for so far as the use of carbon, if a man wants to do a good job he can come pretty close to doing it, and if he wants to make a bad one he can do it. As I understand it, Mr. Trapnell is not recommending his way.

A. A. Helwig: It does away with much correspondence with the agent. Where we get 10 or 15 claims from the agent, it means taking down back records. At Kansas City they let the agent do it himself.

W. J. Stoll: Our system has been in force since 1910 and the trouble with it from the agent amounts to nothing. The records are so handy that in a very few minutes we can dig up records of five years back.

E. R. Campbell: We are using the type of blank furnished by Mr. Trapnell. We only make three copies, one copy for the chief inspector's office, one for the inspector on interchange and one goes to the Western Weighing Association, which has a bill of lading over all the roads.

E. H. Mattingley: I do not want Mr. Trapnell to understand that I am taking exceptions to his form, but I do object from practical experience in trying to insist on a car inspector making three or four copies at the time he inspects his car.

President Gainey: One of the finest records I ever saw in a chief interchange inspector's office was in Mr. Stoll's

office at Toledo. I could pick out anything in 5 to 10 minutes. I do not approve of making four or five of these copies, as suggested by Mr. Trapnell, but I do believe in a regular form. The inspector takes his record in a book of the entire cut, and makes a report to the delivering line, the foreman of the receiving line and one to the chief joint inspector, keeping the book record. If the claim agent wants to know anything about that car and can give the date received the inspector will give him the defects in less than five minutes. We ought to have a regular form, but like the others, I do not think an inspector should be required to make four or five copies in the yard.

F. W. Trapnell: That isn't part of my recommendation. The only recommendation is that we have a uniform blank.

M. W. Halbert: We have used a form 3½ in. by 9 in. for 10 years. The inspector uses one piece of carbon and takes two copies. We have a pigeonhole just the size of these slips. We have 24 railroads and 100 connections from which we receive these daily reports. All cars received by each line are separated. All cars delivered by the same line are kept separate. All we have to do is to go right to the pigeonhole. We can get a record in two minutes of every car that is handled. The reason we made the form that size is that it fits the inspector's pocket. We have no trouble whatever. It is a nice clean proposition for the inspector and everybody else.

A. Kipp: I was one of the committee and it does not seem to me that we are getting anywhere, or that this body could do anything more than make a recommendation that this blank be a standard blank to be used throughout the country for making records, and until such time as that is approved by the A. R. A. we have no authority to say that it shall be used. We can go on and keep just such records as we see fit, and if we do not agree to use this blank we can use a book. It seems to me with all this discussion this association should do one thing or another, accept this committee's report and recommend a blank, or to reject it.

W. M. Herring: In the southeast we cannot require an inspector to furnish a record to the transportation department. Any information they get, must be obtained from the mechanical or car department. (The motion for the adoption of the report was put and carried.)

Secretary-Treasurer's Report

The Auditing Committee reported that the books of the secretary-treasurer had been audited and found correct.

REPORT OF SECRETARY-TREASURER.

Cash on hand, Sept. 23, 1919		$125.75
Collections for Dues, 1919-1920		1,106.00
Total cash on hand		$1,231.75
Disbursements—		
Reporting 1919 Convention	125.00	
Subscriptions to *Railway Mechanical Engineering*	520.50	
Postage	48.00	
Printing and stationery	157.89	
Officers' badges for W. J. Stoll, H. J. Smith, W. McMunn	90.00	
Salary of Secretary	150.00	
Miscellaneous expense	21.24	
		1,112.63
Total disbursements		$1,112.63
Balance on hand		119.12
Members in good standing Sept. 23, 1919	240	
New members	109	
Members in good standing Sept. 14, 1920	349	
Members deceased during the year— C. D. Mitten, St. Paul, Minn.		

Election of Officers

The following officers were elected by unanimous vote: President, Edward Pendleton, general foreman, Chicago & Alton, Chicago; first vice-president, A. Armstrong, chief interchange inspector, Atlanta, Ga.; second vice-president, W. T. Westall, special inspector, New York Central, Cleveland, Ohio; secretary, W. P. Elliott, general car foreman, Terminal Railroad Association of St. Louis, East St. Louis, Ill. Members of Executive Committee (to fill vacancies): W. H. Sherman, car foreman, Grand Trunk, Sarnia, Ontario; A. Herbster, assistant master car builder, New York Central, Chicago.

Other Business

At the Thursday morning session, the arrangement made for publishing the official proceedings of the convention in the *Railway Mechanical Engineer* was ratified and the matter was left to the Executive Committee for further action next year.

The entertainment provided by the Supply Men's Association during the meeting included a trip to the top of Mt. Royal; an informal reception and ball; a tea party; a theatre party; and a sight-seeing trip around the city of Montreal.

The resolutions committee, T. J. O'Donnell, chairman, reported as follows: The members of the Chief Interchange Inspectors and Car Foremen's Association of America in closing their twentieth annual convention in the city of Montreal, Quebec, wish to repledge and offer our fullest individual and mutual support to the mechanical and car department officials throughout the country for the purpose of bringing about the very best and most efficient service that the public and higher executives demand or hope to carry on in the future, realizing the efforts and labor required from each and every one in railroad service to bring such results about.

The Chief Interchange Car Inspectors and Car Foremen desire to express their united appreciation and sincere thanks in closing this annual gathering in Montreal to the following who have contributed to the success of this meeting and the pleasure of the guests while in this City:

First, to the City of Montreal, including the press, and the officers of law on the street, for their uniform courtesy.

To the Hotel Windsor for their excellent service and permission to many of our members to sit up all night in their lobby. (Applause.)

To the beloved and loyal gentlemen of the Supply and Entertainment Committee for their indefatigable and unceasing efforts at this convention, as in many of the past, to make our stay and convention such a pleasant and grand success.

To the railway officials in this district, particularly James Coleman, of the Grand Trunk, to E. Arnold, of the Grand Trunk, to J. E. Grant and T. O'Donnell for their inspiring talks and valuable suggestions for the guidance of this association, as well as to the officials of the Canadian Pacific and other railways for their attendance and interest in our numerous gatherings, and help in making our stay most pleasant and return to our homes most agreeable.

To our presiding officer, J. J. Gainey from Ludlow, Kentucky, we tender our heartfelt thanks. While we have known his genial and pleasant disposition in the past, we have gladly recognized it in the highest position of our association, that of presiding officer.

To our secretary Mr. Keene, who leaves us after one year of service, we extend our sincere thanks for his efficient service. We are very grateful to Miss Unkenholz for her courtesy as our stenographer. And to all the people in Montreal who have contributed toward our pleasure while we have sojourned here, we are deeply indebted.

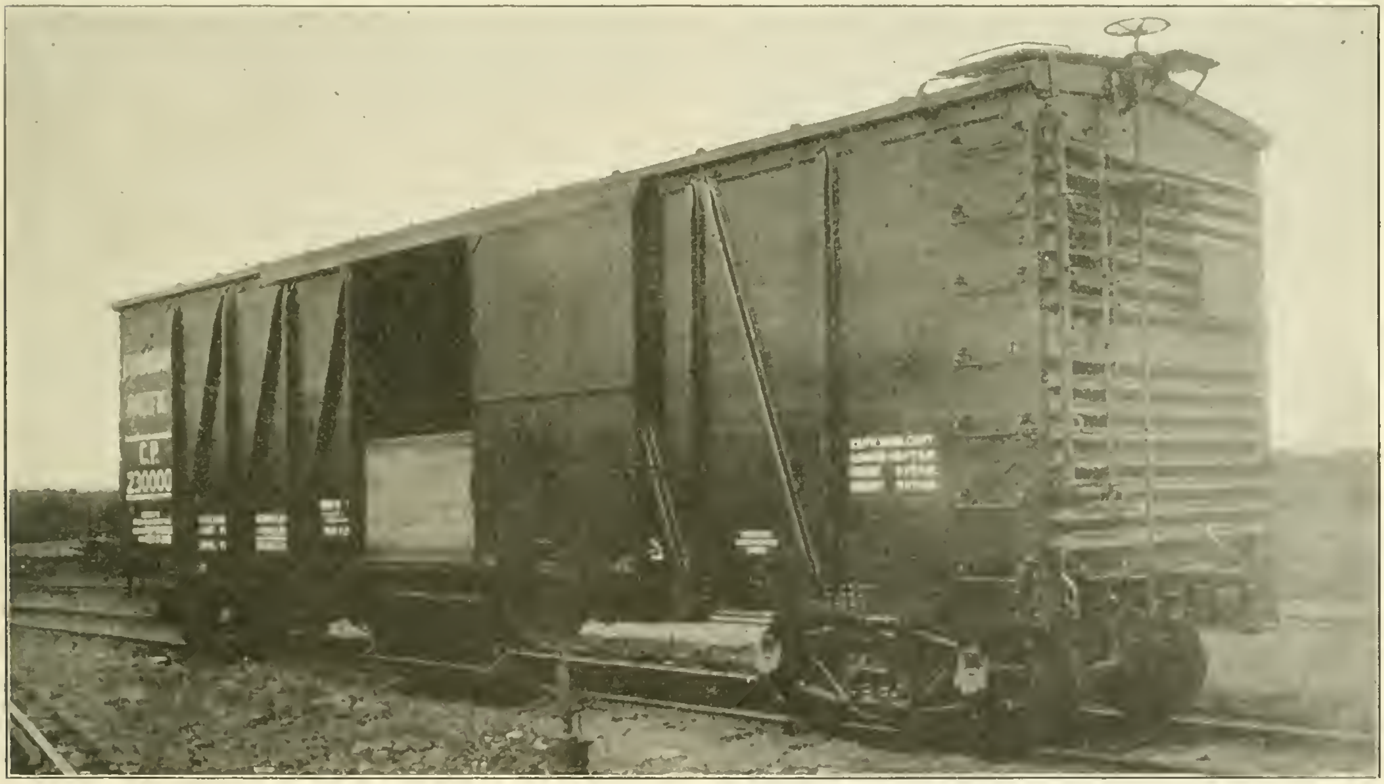
May we return to our homes full of hope, and may future gatherings, wherever they may be held, be as pleasant and splendid as this great convention has been in Montreal.

The convention closed with the singing of the national anthem of the United States.

Canadian Pacific Hopper Bottom Box Cars

High Radio of Load to Gross Weight in New Equipment Designed Especially for Grain Service

TWO features which make the equipment particularly suitable for service on a road with a heavy grain traffic stand out strongly in the design of the latest box cars recently placed in service by the Canadian Pacific. The limit load which the cars will carry is 60½ tons and the floors of the cars have special hopper bottoms which are designed to facilitate unloading of bulk material and to eliminate the need for temporary grain doors. Roads that have a heavy merchandise traffic generally consider that the cubical capacity usually limits the load in a box car and, therefore, a 40-foot car with a limit load of about 45 tons is most economical. However, where much grain and coal are carried in box cars, as is the case on the Canadian Pacific, the extra cost of the heavier car is, no doubt, more than offset by the higher ratio of load to total weight in a fully loaded 60-ton car. In these cars, which are 40 ft. 6 in. long, 8 ft. 6 in. wide and 9 ft. high inside, the ratio of load to gross weight is 71.4 per cent.



Box Car With Burnett Hoppers Built for the Canadian Pacific

Type of Construction

The cars are built with steel underframes, steel side frames, corrugated steel ends and outside metal roofs. The center sills consist of two 12-in. channels continuous from end to end of the car. The bolsters and cross bearers consist of pressed steel diaphragms with top and bottom cover plates, while the floor beams are pressed steel diaphragms. The decking, which is 2¼ in. thick, is secured directly to the center and side sill flanges by means of bolts.

The side frame consists of 9-in. channel sills, 6 in. by 3½ in. by ⅜ in. angle plates, 4-in. Z-bar door posts and U-shaped pressed steel posts and braces. The side sheathing, which is 1½ in. thick, is bolted to the flanges of the door posts, pressed steel intermediate posts and braces and to the flanges of the corrugated steel ends. Pressed steel posts and braces were chosen in preference to rolled sections because the ends have area for riveting without the use of gusset plates, and the ends of the braces can be brought much closer to the ends of the posts; also the pressed shapes provide superior support for the sheathing boards. The ends of the car are of pressed steel, each end being in two sections.

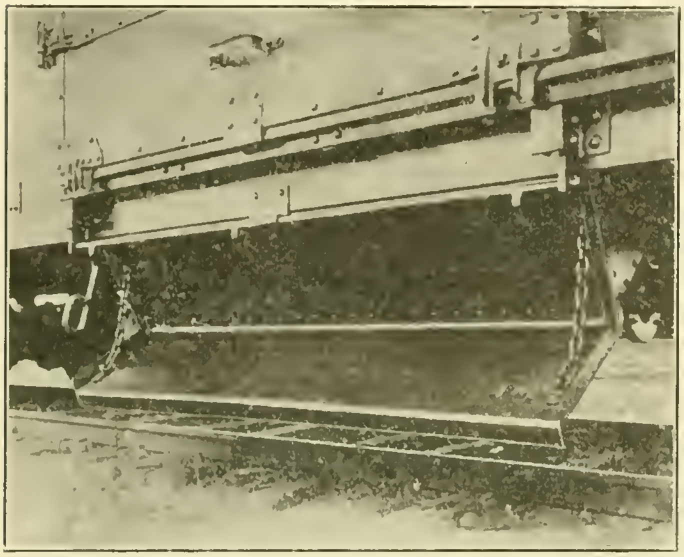
The roof is of the flexible outside metal type supported on metal carlines. All carline flanges are covered with strips of wood arranged to prevent the accumulation of dust that might be shaken down from time to time and possibly damage the lading.

Grain Hoppers

Hoppers of the Burnett type are located at the side door opening on each side of the car. When used for freight that cannot be dumped through the hopper the car has a solid level floor, the same as an ordinary box car; when grain coal, etc., are to be loaded the specially constructed sections of floor over the hoppers are turned up against the side door post. This arrangement allows the load to go directly into the hoppers, and also saves considerable temporary door lumber. When the cars are unloaded it is only necessary to remove the pin that locks the hopper doors; the doors open quickly by gravity and immediately a large percentage of the contents of the car discharges through the hoppers. The balance of the load may be shoveled to the middle of the car by hand, or if the unloading plant is equipped with power shovels, as most elevators are to-day, the floor door on one side of the car is released from the door post and the cables are taken through the door opening as usual. The

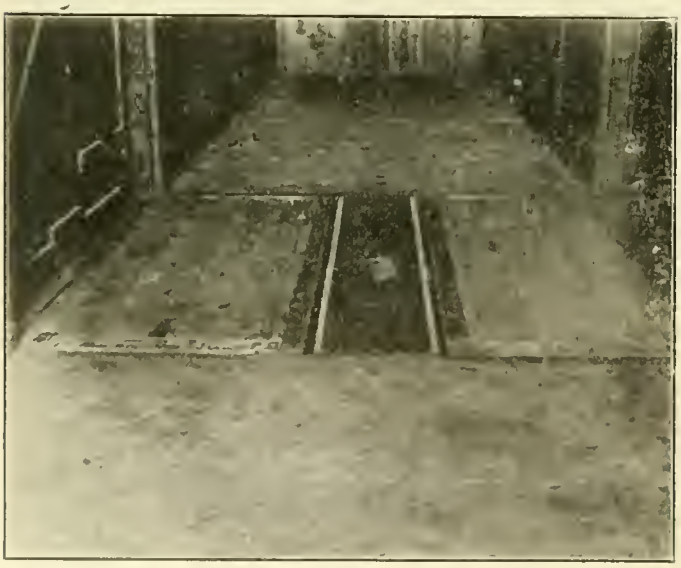
hopper doors have no operating mechanism, the doors being closed directly by hand and secured by a simple locking bar arrangement.

Special care has been taken to obtain a side door of satisfactory design. The interlocking front and back edges afford exceptional protection against weather and pilfering. The top edge is thoroughly weatherproof, yet so arranged that it cannot become blocked with ice. The bottom of the door is fitted with turned rollers that fit on a very substantial and rigidly supported track. This track is not likely to be blocked with ice but in case it should be the interference is plainly visible and easily removed. The location of the rollers at the bottom of the door does away with the binding or cramping so frequently noticed on doors suspended from the top.

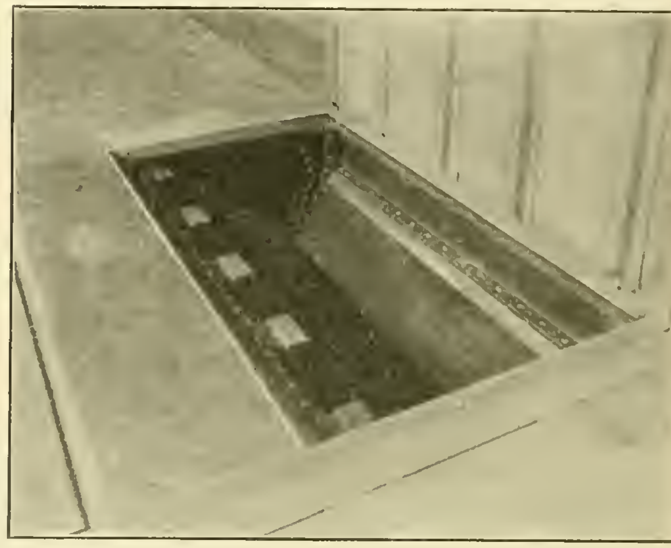


The Hopper When Open Discharges Outside the Track

The brake arrangement includes a manually operated slack adjuster, which is a double safety device, as it enables inspectors to adjust the brakes to compensate for wear on brakeshoes without going under the trucks; and, as no truck parts are disconnected, the possibility of trouble due to oversight in replacing connection pins is eliminated. As the time required to adjust the brakes by this device is much less than with the old arrangement it enables inspectors to give attention to more cars in a given time, thus resulting in better maintenance and less detention. The hand brake arrangement is specially designed to be operative regardless of climatic conditions, this being accomplished by arranging the ratchet, pawl, etc., so that snow or ice on top of the parts will not interfere with their operation. The entire arrangement is located overhanging the end of the roof so that it is impossible for even the deepest snow to pile up underneath. The ratchet pawl is of the gravity type, and therefore the trainman is not required to use his feet for holding the pawl in position.



Interior of Car With Hoppers Closed



Floor Section Raised for Grain Loading

The trucks are of the standard arch bar type with improved truck columns, spring plank and truck column fastenings, pinless brake beam hanger brackets, and four-point brake beam suspension. The railroad states that up to date this type of truck has given the best satisfaction in Canada.

THE SUCCESSFUL FOREMAN*

BY W. P. ELLIOTT

General Foreman, T. R. R. A. of St. Louis

To my mind a successful foreman possesses two very important qualifications. One is loyalty, and the other is ability, which, of course, covers a very broad scope. It has been said that an ounce of loyalty is worth a pound of cleverness. I have often thought in my contact with men and in the daily performance of my duty how necessary loyalty was to success. Be a man ever so clever, without loyalty to the company or individual he is working for, his cleverness or ability is liable to be more detrimental than beneficial.

During the period of federal control I visited nearly every car shop and repair shop in the St. Louis and East St. Louis terminal. During that time the salary of a car foreman was hardly in proportion to the ability and responsibility expected. That has, in a large measure, been rectified since that time. However, I could not help noticing the attitude of some of the men filling supervisory positions. Regardless of the wage conditions or the working conditions under which foremen were working at that time, there was hardly any excuse for the attitude of some of them. The dissatisfaction was so apparent that it had its effect on the men that were working under the foreman. That "don't care" spirit went out to the men they were expected to lead, and the result was about what was to be expected.

I think one of the best characteristics of a foreman should be his ability to overcome difficulties, personal difficulties as

*From an address delivered before the St. Louis Car Foremen's Association

well as difficulties that come up in his daily work. If the foreman would be successful, it is essential that he be considered as to his capacity for accepting responsibility and his capacity for leadership. I do not know exactly what to attribute the lack of acceptance of responsibility to, unless it is due to labor organization. It seems that labor organizations have caused men, rather than leaning on their own responsibility, to lean on some organization or some set of men. For a man to be successful in a supervisory capacity, he should lean entirely on his own resources. Within the past two years especially there has been a disposition for men to say, "Why should I want the responsibility? Why should I take the leadership." And to my mind those men are not successful foremen.

When a foreman is given charge of a plant, regardless of its size, he should feel the responsibility of the management of that plant, and he stands in identically the same relation toward his superior as the general manager stands toward the corporation. He should be keenly interested in the success of that plant, and he should be keenly interested in the economical operation and should feel the same responsibility regarding its management that he would feel if it was his own individual property.

The car foreman today has an exceedingly responsible position. As an example let me cite the hazardous and highly perishable commodities now handled in tank cars. Few foremen realize the responsibility connected with the handling of this class of equipment. The tank car itself is relatively simple, but the commodities it carries makes exceptionally intelligent handling necessary. I have found that the simplest of defects have been considered serious by many car foremen and inspectors and many of the more serious defects have been considered simple. This has been due to lack of knowledge of the cars and their commodities. A foreman should know the United States Safety Appliance laws, and he should know well the rules of the Mechanical Division of the American Railway Association, and he should subscribe for books and periodicals that deal with the car department.

There are very few periodicals at the present time that go into car department matters very thoroughly. However, the car man himself is as much responsible as the publisher, if not more so. Publishers are always glad to receive subject matter from men who are on the ground, but car department matters have been principally covered by mechanical engineers, bill clerks, master mechanics and others who would be less liable to understand real car conditions and methods than the car man.

One of the features in being successful is to properly spread abroad your ideas so that other car men will have a chance to criticize them, either favorably or unfavorably. To my mind there is no other one thing that so broadens a man as association and discussion of the problems that confront us in our daily activities. I would like to see the car foremen get the habit of reading articles and talking upon matters that concern our daily duties.

For instance, as an idea for a subject, how far have we gone into the question of economical lubrication? What ideas have any individual car men put out as to the preservation of cars by painting? What ideas have we put forth or what action have we taken towards the proper inspection and the maintenance of draft gears, and what system of repairs have we suggested for draft gear, which is very essential to the proper handling of freight cars today? I recall very few papers that have been written on the question of brake beam failures, and yet there is no other one thing that is as important to us today. I think it would be a good thing for you, a good thing for the association and for car men in general, if there was more written on these subjects and more discussion of them by practical car men.

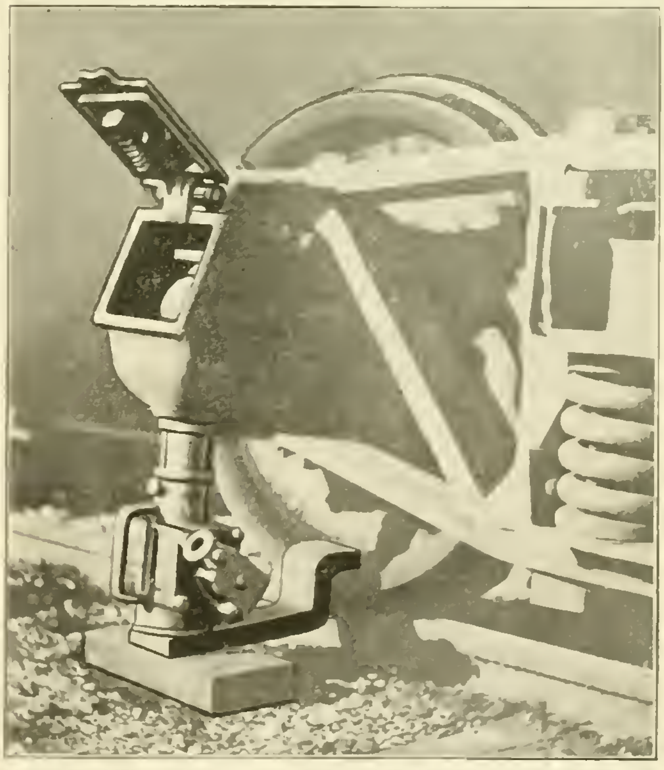
There is much that could be said that would be of assistance to car men towards success, but the things that come most forcibly to my mind are: be loyal, respect your superior and if there is any shortcoming, see that he knows about it, and I am sure that you will be given proper consideration. Invite responsibility. If there is any one thing that will make for success, it is that. Everyone admires a man who invites responsibility, and it gets back to the old saying that a man who does not make a mistake is not a real man. When you invite responsibility, you invite mistakes, and when you invite mistakes, you are showing your superiors that you are at least progressing.

SIMPLE DEVICE AIDS IN CHANGING CAR JOURNAL BRASSES

BY ROBERT I. LILLIE

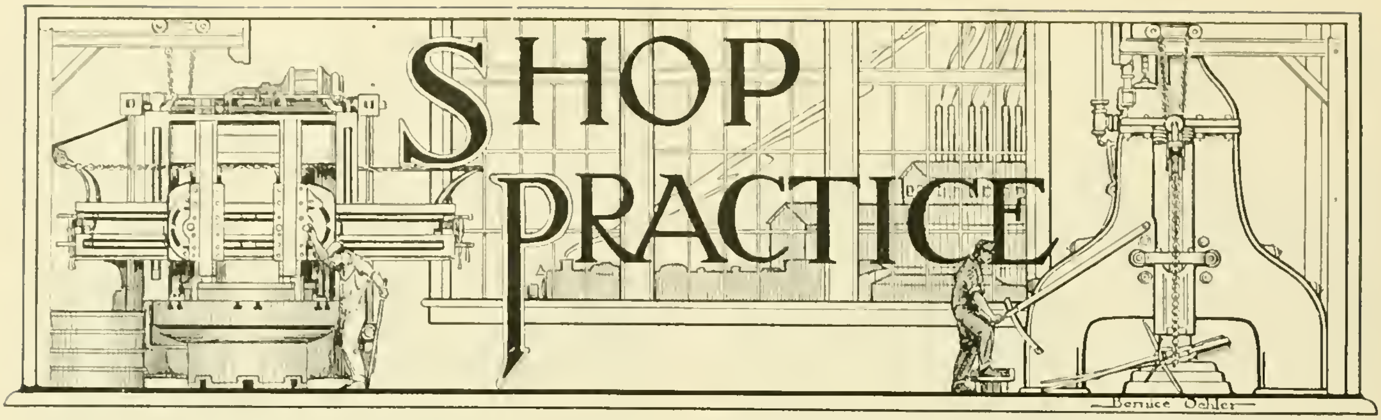
All car shop employees, especially those responsible for work on the rip track, realize the difficulty that often is met in changing brasses or making other repairs to journal box parts. It is necessary to use a jack to lift the box from the journal and many times the wheel raises at the same time and has to be driven back by hammers or wedges between the wheel and the car body.

To obviate this difficulty a simple arrangement, illustrated, has been devised. An old brake beam lever is bent as indicated and placed with one end resting on a block, the other offset end being supported on the inside rim of the wheel. When a jack is applied between the brake lever and bottom of the journal box, it is evident that operation of the jack will cause the journal box to lift, the wheel being held down by one end of the brake lever.



Efficient Arrangement for Jacking Up Journal Box

By placing the jack a little nearer the rail than shown in the illustration, there will be even less tendency for the wheel to lift. This device is sometimes called a wheel holder. When made from scrap truck levers it is inexpensive to make and its use results in a considerable saving of time and labor in making journal box repairs.



Lining Driving Box Shoes and Wedges

A Shoe and Wedge Lay-Out Which Involves Little Possibility of Error; Pedestal Jaw Grinding Machine

BY J. McALLISTER
General Foreman, West Albany Shops, New York Central

One important object in laying out shoes and wedges is to place driving wheels under the locomotives so that the tire flanges will not cut or wear more on one side than on the other. That this object is not always attained with the usual method of laying out shoes and wedges is evident from the large amount of flange cutting which is found in practically all locomotive shops. It is a common occurrence, after a locomotive has received general repairs to see on the work report, "Throw wheels on account of flanges cutting."

Years ago when locomotives were small and parts light and easy to handle, a sharp flange was not so serious a matter as at present when motive power is relatively heavy. At the present time a flange which shows signs of cutting is often neglected until it becomes so bad that the wheels must be dropped and tires changed, or the locomotive sent to the shop for tire turning. The result is a low mileage and high cost of maintenance.

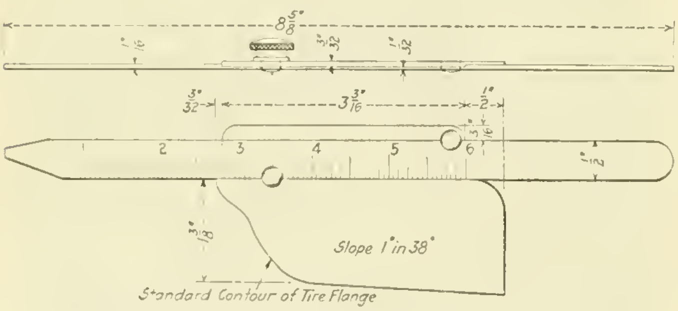


Fig. 1—Gage for Measuring Distance Between Tire Flange and Locomotive Frame

The method usually employed in laying out shoes and wedges is to work from the centers of the cylinders, tramming back to the frame jaws. There really is no good reason for working from the cylinders, however, as the only connection between them and the wheels is the main rods, and they must be adjusted to equalize piston clearance. With this fact in mind and with a view to getting data which would demonstrate the value of the proposed new method of laying out shoes and wedges, the gage shown in Fig. 1 was made. This gage consists of a piece of 3/32 in. steel shaped as indicated to fit the standard contour of a tire flange. A movable or sliding scale, graduated as shown, is arranged to be clamped in any desired position by means of a thumb screw. The method of using this gage is plainly shown in Fig. 2 and consists in measuring accurately, at the two positions shown, the distance between the working side of the flange and the frame. The theory was that if these distances proved to be equal, the flange must be parallel to the locomotive frame and would not, therefore, cut or wear away faster than the flange on the opposite wheel.

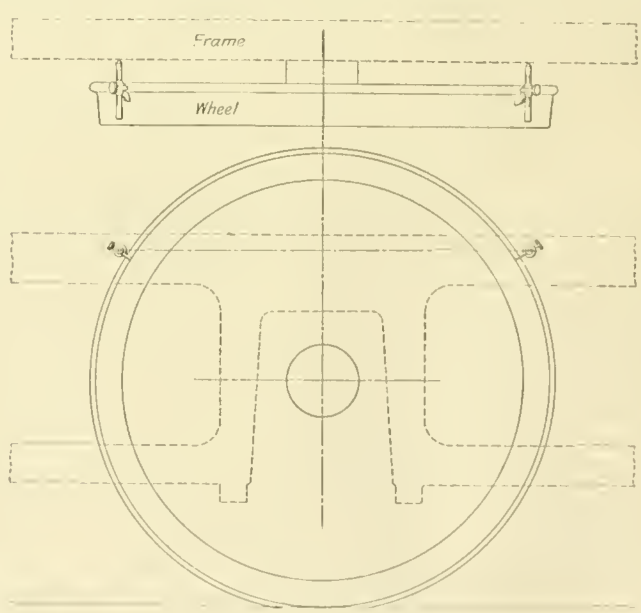


Fig. 2—Method of Using Gage

Several precautions had to be observed in the use of the gage. It could be used in the case of turned tires only because of the possibility that new tires might not be shrunk on in exactly the right place. It was found necessary to check only the main wheels, the other wheels being trammed from the centers of the main wheels. In taking measurements with the gage, two points were selected on the front and back of

the wheel on a line parallel with the top of the frame. This is illustrated in Fig. 2.

All locomotives coming to the shop for a certain period were tested with the gage previously described, and it was found that when the wheels were parallel with the frame, all flanges were worn evenly; when not parallel, they were cut on one side or the other. The practice was then adopted of gaging the wheels in the shop after the locomotive had been wheeled, the shoes, wedges and binders put in place on the main jaws and the wedges set up tight. When the gage showed that the flanges were not parallel with the frame, the

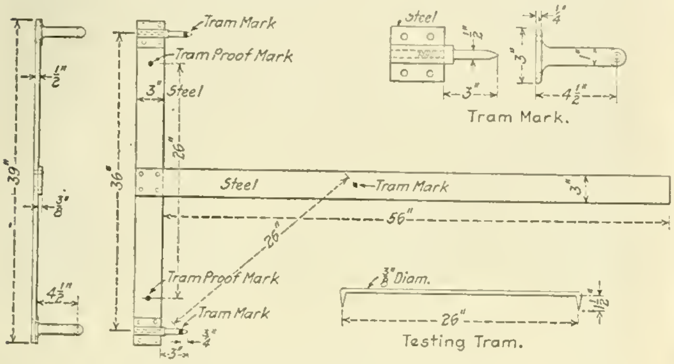


Fig. 3—T-Square for Laying Out Shoes and Wedges

binders were pulled down and the shoes and wedges relined to correct the error.

The results of the above practice were in a way surprising. No matter how carefully the laying out was done, it was found necessary to throw the wheels more or less on about 60 per cent of the locomotives. The improvement in flange cutting which followed was so pronounced that the extra work entailed in throwing the wheels was felt to be well worth while. Practically doing the work twice, however, was expensive and the attempt was made to find a better method of laying out shoes and wedges.

Method of Laying Out

Having proved conclusively that flange cutting on one side of a locomotive could be eliminated if the work was done properly and checked with the gage, it was decided to standardize the work and develop a set of jigs and gages which would reduce the possibility of errors to a minimum. The method of laying out is explained, the jigs and gages being described in the order in which they are used.

After locomotives are stripped in the erecting shop and necessary bolting done, the frame jaws are inspected by the erecting shop foreman in charge. If the jaws are found to be worn, they are trued up with the grinding machine illus-

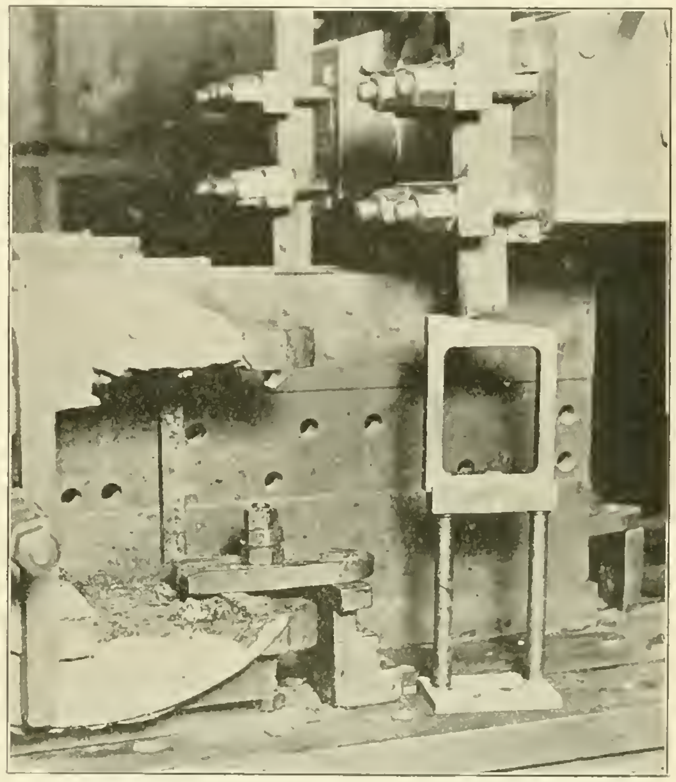


Fig. 5—Gage Used in Setting Tool for Planing Boxes

trated and described later on in this article. This machine does accurate work, saves the labor of filing and removes just enough metal to true up the surface of the jaw.

Referring to the lay-out shown in Fig. 4, the box center is located on the main jaw and a vertical line drawn through the center, using a small square. The T-square, illustrated in Fig. 3, is now brought into use. This is not a plain T-

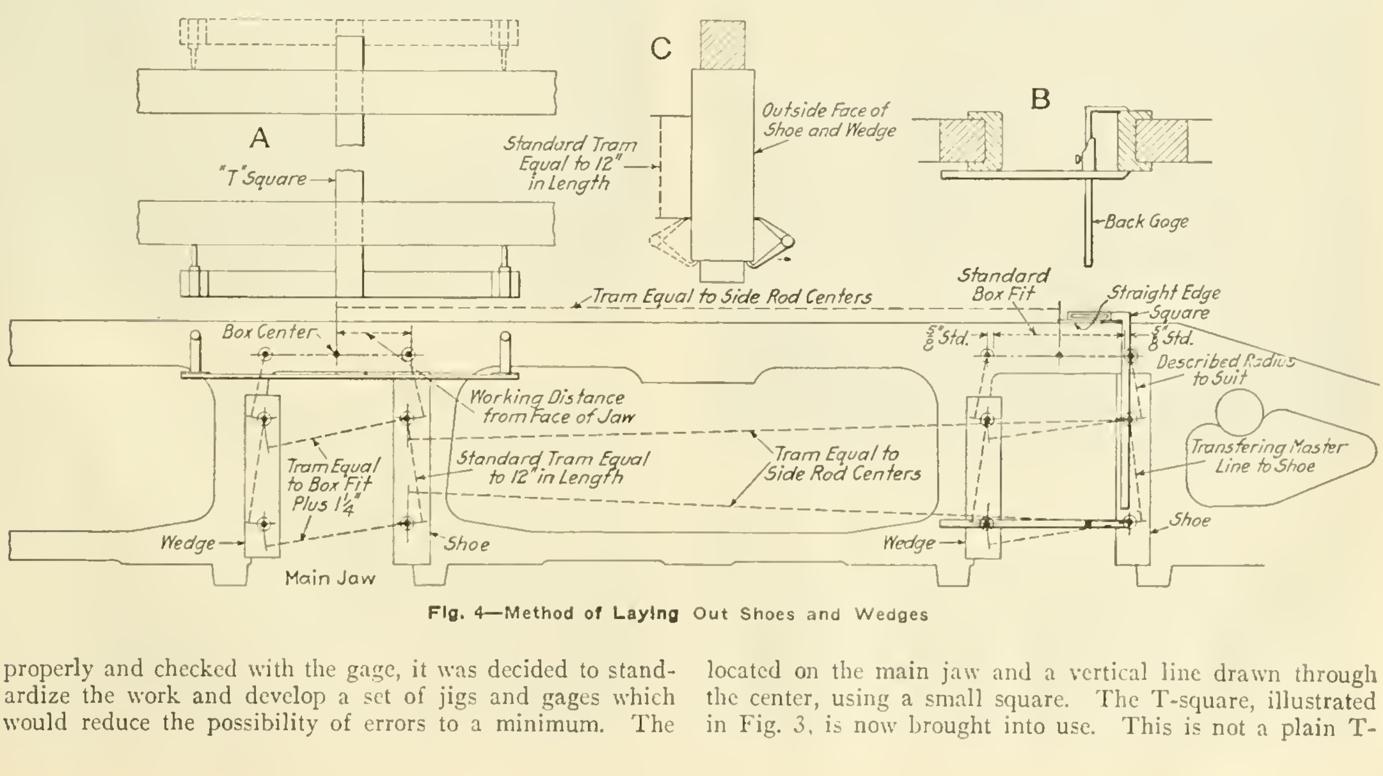


Fig. 4—Method of Laying Out Shoes and Wedges

square, but has two projecting points raised a set distance above the square, an arrangement which clears the bolt heads and allows the points to come in contact with the frame at points not subject to wear or incorrect alinement. As shown in the illustration, a 26-in. testing tram is provided to make sure that the square is correct each time before it is used. The testing tram itself may be checked from time to time by means of two points shown on the T-square head 26 in. apart.

Referring to Fig. 4, the T-square is now placed across the frames as shown at *A* and the box center transferred to the opposite frame. By placing the square on the other side of

ENGINE NO. __________			
BOX	GAGE NO.	BOX	GAGE NO.
R-1	1	L-1	1
R-2	1	L-2	1
R-3	1	L-3	1
R-4	1	L-4	1

ENGINE NO. __________			
BOX	GAGE NO.	BOX	GAGE NO.
R-1	1	L-1	3
R-2	2	L-2	4
R-3	1	L-3	1
R-4		L-4	

Fig. 6—Charts Showing Gage Numbers to Which Boxes Must Be Planed

the locomotive frame, the work can be checked by squaring back. If the marks do not coincide, the frames are out of parallel, in which case lines are stretched through the center lines of the cylinders to determine where the frames are out. If the marks check, however, the frames are square and work on the lay-out may proceed.

A careful consideration of Fig. 4 will make the method of

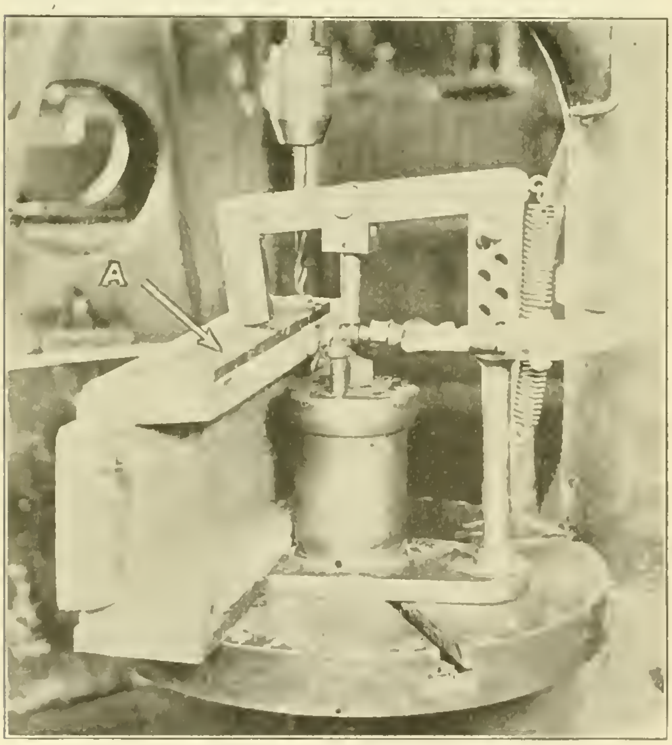


Fig. 7—Jig Used When Drilling 3/8-In. Location Holes

laying-out practically self-evident. A square and straight edge are used, as shown to square down from the top of the frame and proof marks are prick punched 5/8 in. outside of the driving box sizes, the standard box sizes being those shown on the blue prints for the particular class of locomotive involved. When all shoes and wedges are laid out on the outside of the frame, the marks are transferred to the inside of the shoes and wedges, using a back marker, shown at *B*, Fig. 4. The vertical positions of the proof marks are transferred as shown at *C*, Fig. 4. This provides a form of layout which is necessary when using the shoe and wedge planer to be described later. The responsibility of the erecting shop, except for a final checking, is now ended.

Machining Driving Boxes, Shoes and Wedges

Driving boxes are delivered to the machine shop, new crown brasses applied and the shoe and wedge fits relined.

Fig. 8—Shoe and Wedge Planer Chuck

The boxes are then placed on a planer and machined to a standard size, using the gage shown in Fig. 5, a separate gage being provided for each class of locomotive. The driving box is then stencilled to show the size between shoe and wedge faces and delivered to the boring mill, where it is bored to actual size, a universal chuck being used to center the box.

It will be noted that the gage illustrated in Fig. 5 is a step gage, each step decreasing by 1/8 in. This arrangement is to provide for light repairs when driving boxes are not rebrassed but simply trued up. The tool is set to whatever step the box will true up at and stencilled 1, 2, 3, 4, 5 or 6, as the case may be. A chart is now made out by the wheel foreman,

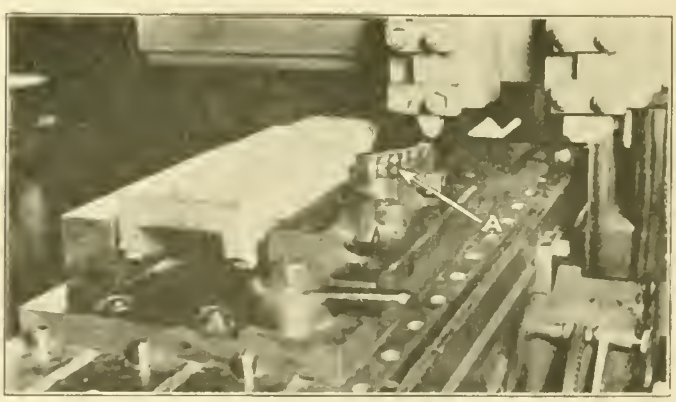


Fig. 9—Driving Box Shoe Set Up Ready for Planing

as illustrated in Fig. 6, showing the locomotive number, each driving box number, and the gage number to which it was planed. Two charts are shown in the illustration, one being for a set of driving boxes rebrassed and planed to standard sizes, and the other showing the sizes to which a set of light repair driving boxes were planed without being rebabbitted. The chart after being made out is delivered to the man who operates the shoe and wedge planer.

While the driving boxes are being planed, the shoes and wedges are delivered to a sensitive drill, which is placed near the shoe and wedge planer. The jig *A*, Fig. 7, is then used in drilling the holes which are to hold the shoe or wedge in correct position for planing. As shown in the illustration,

the jig consists of a metal bar with a hardened steel bushing in either end to guide the ⅜-in. drill. These bushings are 12 inches apart, as are the two guiding points arranged to enter the proof centers and thus indicate the correct position for the jig. The jig is held in place by means of a pneumatic clamp, as shown in Fig. 7, and two ⅜-in. holes are drilled ¼ in. deep on each side of the shoe or wedge.

The shoe or wedge is now placed in a chuck, shown in Fig. 8, being held in the correct position for planing by means of ⅜-in. pegs in the chuck body entering the ⅜-in. holes previously drilled. Two of the ⅜-in. pegs are shown in Fig. 8, the other two being machined on the ends of the holding set screws. The jig and chuck, shown in Figs. 7 and 8 respectively, are designed so that when the shoe or wedge is clamped in position the proof center marks are exactly in line with the top of the chuck. A driving box shoe held in position ready for planing is shown in Fig. 9. The proof circles extend ⅝ in. above the top of the chuck. The gage at *A*, Fig. 9, is placed on top of the chuck and the planer tool set to the step called for on the chart, previously issued to the planer operator. Thus, if the box is a standard size, the tool is set to No. 1 step; if it has been planed down and is not a standard size, the tool will be set to the required step. It will be noted that steps on the gage increase by

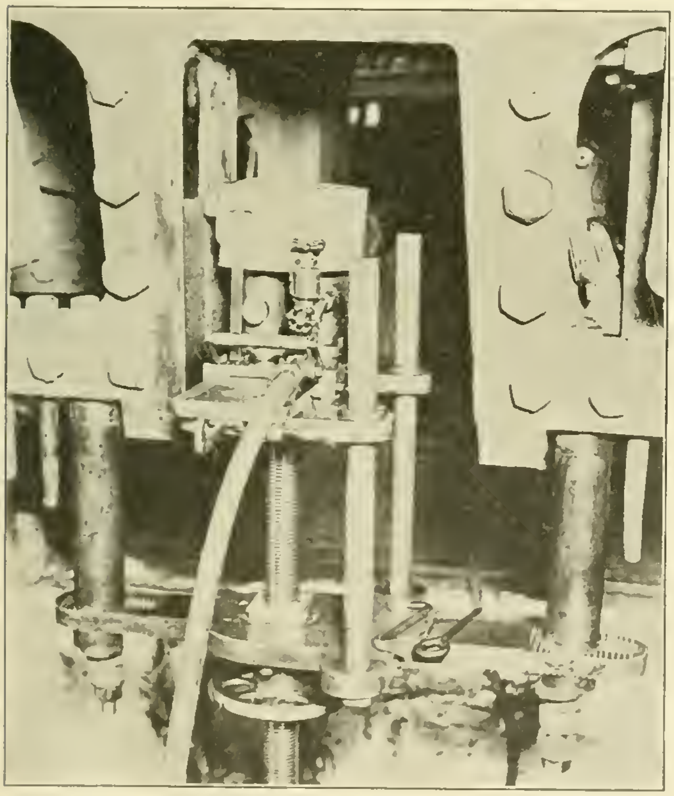


Fig. 10—Pedestal Jaw Grinder Set Up Ready for Operation

1/16 in. so that if the driving box is planed ⅛ in. small, the shoe and wedge by this method will each be planed 1/16 in. large. The chuck automatically sets up the shoe or wedge parallel ready for planing, and the gage determines the tool setting without any further measurements.

Frame Jaw Grinder

It is necessary to start with frame jaws which are true. With cast steel frames, which are naturally tough and become almost case hardened in service, it is practically impossible to true up a frame jaw by filing. Various attempts have been made to perform this work by machinery and one device was designed to machine the jaws by means of a portable milling machine. The two objections to this device were its lack of rigidity and the danger of removing too much metal. Obviously the best method would be to use some form of grinding machine which would cut no matter how hard the surface and remove only enough material to true up the jaws. The machine illustrated in Figs. 10 and 11 was devised for this purpose. As shown in the illustrations, power is supplied by means of an air motor driving a 1 in. by 8 in. grinding wheel through one pair of gears. Both the motor and grinding wheel are arranged for vertical movement by means of a square threaded screw, guided by two upright rods securely fastened in the base plate. The grinding wheel is guided in its horizontal movement across the face of the frame jaw by means of the V-ways shown. The device is supported by two bolts through the bottom frame rail, the base plate being held at the required distance from the

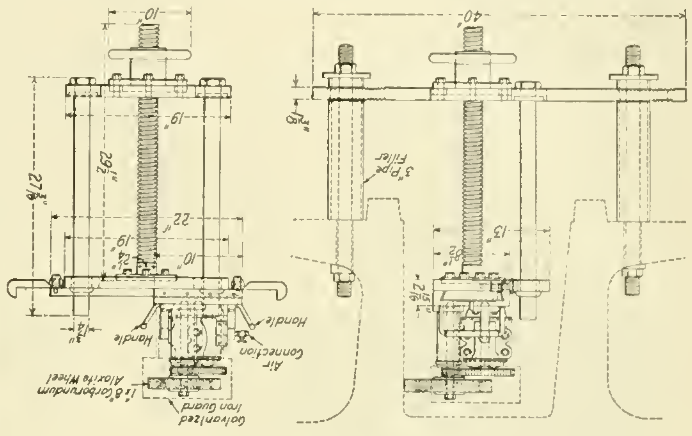


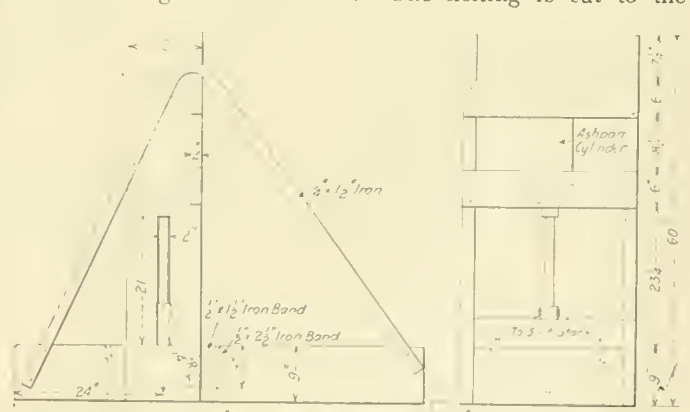
Fig. 11—Details of Pedestal Jaw Grinder

rail by means of two pipe thimbles. When it is desired to grind the wedge jaw face a set of pipe thimbles are used which are cut off to hold the base at an angle of 5 deg. This arrangement brings the two machine guides parallel to the frame jaw. A galvanized iron guard is provided for the wheel, as illustrated. Experience has shown that this grinder does a first-class job, especially on wide extension frame jaws, and removes just enough metal to true up the jaws.

PRESS FOR FORMING STACK HOODS

BY C. E. YOCUM

On roads where a hood is used over the stack to avoid setting fires from cinders, the press shown in the sketch will be found a great labor saver. The netting is cut to the



Air Press Reduces Labor in Forming Stack Hoods

proper size and placed centrally over the hole in the base of the press. The air-operated cylinder forces the former down and draws the netting into the proper shape, thus greatly reducing the hand work required.

THE TESTING OF WELDS IN STEEL PLATES*

Conditions Which Affect Quality of Welds; Simple Bend Test and Etching of Sections Recommended

BY S. W. MILLER
Rochester Welding Works, Rochester, N. Y.

THERE have been many failures of welds in the past, some not explained and some very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds both from a standpoint of security, service and cost. While some of the methods employed at present are beyond the reach of the ordinary welding shop, yet they are of great value and, in fact, necessary in order to determine correctly what has occurred during the welding operation and what results may be expected under given conditions. Most of the published results are incomplete in one or more respects and one of the objects of the American Welding Society is to put the testing of welds and welded structures on a firm and safe foundation.

Common Methods of Testing

The testing of metals, aside from welds, is quite well developed both in theory and practice. The usual test is the tensile test that gives the tensile strength per square inch, the yield point or elastic limit in pounds per square inch, the elongation in per cent of the original gage length and the reduction of area in per cent of the original section. Compression, torsion, shock and alternating stress tests are also used and the two latter are beginning to be used much more than they have in the past because it has been found that materials may give high results in the tensile test and yet be entirely unsuitable to resist service where shock or alternating stresses are met. Another of the common tests is bending to a certain radius either hot or cold and it has been found that it is a very valuable test of certain qualities.

Chemical analysis is another powerful method of investigation and many specifications have been made in which its use is vital.

The microscope has been found to be of tremendous help in the study of metals and, in fact it is now a necessary instrument in all laboratories. Its principal function is to determine the extent and location of impurities in a metal, to decide whether the structure is proper for the purpose desired and to decide whether various heat treatments will give satisfactory results. While no one method of test shows everything desired to be known, the microscope is probably the most powerful single method of investigation in the case of metals, and in the study of welds it is particularly valuable because of the method of their formation. A weld is a casting and is subject to all the defects found in castings, which are, however, exaggerated in the case of welds.

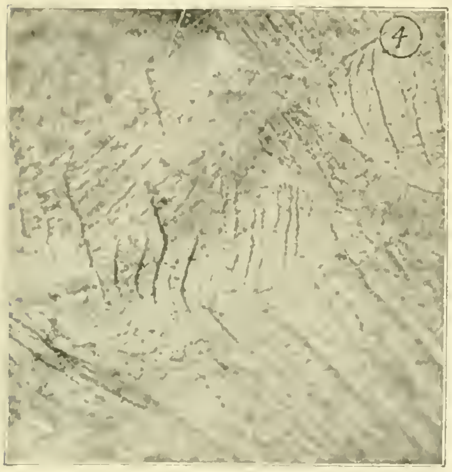


Fig. 1—Strained iron. The curved lines are not cracks, but the edges of parts of the grains that have slipped past each other. They are called slip bands.

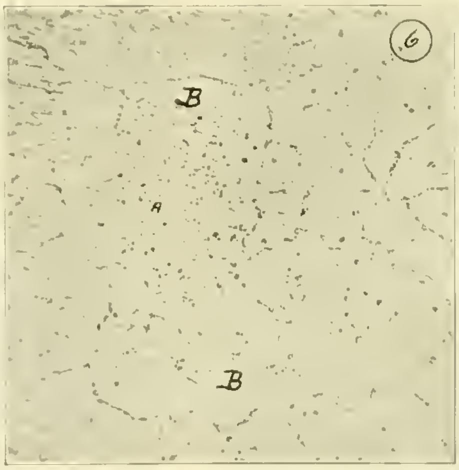


Fig. 2—A good looking oxy-acetylene weld, but made with too large a tip, as shown by the short straight lines in some of the grains.

Fig. 3—Oxy-acetylene weld showing heavy slipping at grain boundary. This is not a crack, but shows a weakness.

Welds in Steel Plates Only Considered

This paper is confined to defects in the welding of steel plate by the oxy-acetylene and metal electrode processes. The welds considered are those in some important structure where soundness and high quality are necessary. By soundness, I mean freedom from mechanical imperfections such as lack of fusion, the presence of films or other inclusions, gas pockets, slag, etc. Welds of inferior quality may answer some purposes admirably, and if they do, there is no use in making better ones, but this is not the goal at which to aim for one who desires to make really good welds. The welding of steel is frequently considered as not being especially difficult, and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common to-day than it was several years ago, but it is still too prevalent for the good of the art. A comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is .12 per cent or less, the material is

*A paper read before the September meeting of the Chicago Section of the American Welding Society.

soft, ductile and yields readily to any strain that may be put on it. Such material is frequently used for tanks, and because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about .15 per cent to .25 per cent carbon and have a tensile strength of about 60,000 lb., while the soft low carbon material has only about 52,000 to 55,000. Ship plate is required to have a tensile strength of from 58,000 to 68,000 lb. and in the heavier sections requires as high as .30 per cent carbon.

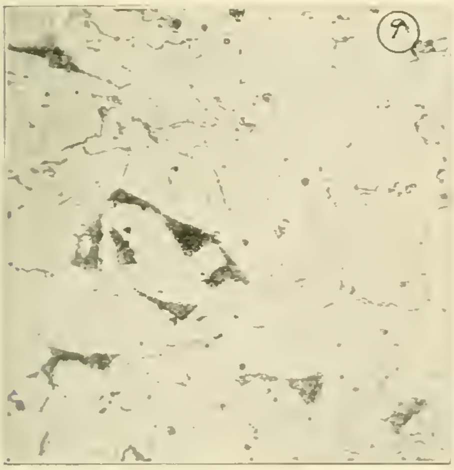


Fig. 4—Good oxy-acetylene weld made with rather high carbon steel. Note presence of slip bands as in all good welds.

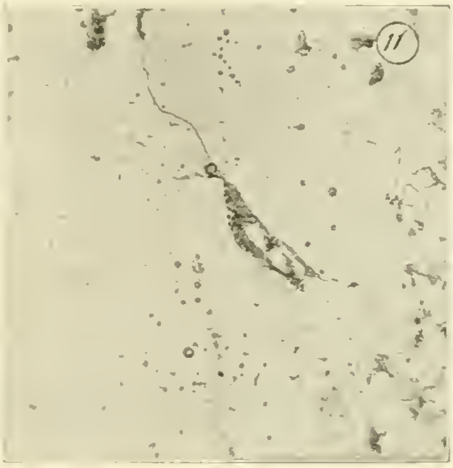


Fig. 5—Film of foreign matter, probably oxide, in oxy-acetylene weld.

Fig. 6—Inter-granular cracks in strained oxy-acetylene weld. No defects visible before straining, showing that films were very thin.

It has been found by experience that the higher the carbon the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. From a metallurgical point of view this is entirely natural and to be expected. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An oxy-acetylene weld made with ordinary low carbon welding wire will have a tensile strength of about 52,000 lb. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an oxy-acetylene weld of about 50,000 lb. Neither of these materials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, so that in making tests of welded pieces, it is necessary to know accurately the character of the material being welded because if Welder Jones makes a weld in soft tank steel and Smith makes one in bar steel, the first will break outside of the weld and the latter in the weld with a probable adverse criticism of Smith's work.

Fig. 7—Arc weld made probably with too long an arc, as there should not be so much iron nitride.

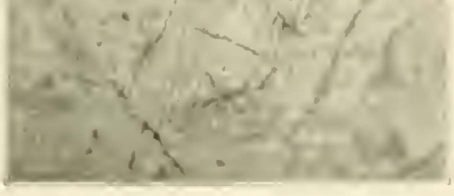


Fig. 8—Slip bands in arc weld. The heavier straight lines are iron nitride. These weaken the weld little, if any.

Fig. 9—Large defect in arc weld. Dark streak is oxide of iron.

Recommended Physical Tests

The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made but that an alternating stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests, but it is advisable, whenever possible, to follow those of the American Society for Testing Materials. Inasmuch as a welded piece is not of uniform character, it is not possible to use the elongation and reduction of area as commonly measured. Where the break occurs in the weld, the elongation of the whole test piece tells

very little about the quality of the weld, and I have been in the habit of taking the elongation in each inch, two inches, etc., of the gage length, beginning at the center inch, which includes the weld, and plotting these figures, against the gage length. Evidently, when the break is outside the weld, the various physical characteristics are those of the original material and not at all of the weld. The best test, in my opinion, to determine quickly the general charcter of a weld is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the V toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throws more of the strain into the weld while soft ductile material will itself take considerable of the bend. In the case of defective welds, that is, those not fused along the V or which contain slag or other inclusions, this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot, such as, for instance, in a locomotive firebox crown sheet, it would be entirely proper to test the weld at a good red heat, and I believe that it would be of much interest to all of you, if you would test some of your welds by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the table or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before with a sledge.

If such welds are made in half-inch by two-inch bar steel, a 90-degree single V being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

Conditions Affecting Quality of Welds

There seems to be quite a definite relation between the thickness of metal, the size of tip and the size of the welding wire, in the case of gas welding, and between the thickness of metal, the diameter of the electrode, and the current used, in electric welding. It is also to be understood that electric welds, except possibly those made with covered electrodes, will not stand as much bending as oxy-acetylene welds.

In many cases, the defects in welds are easily visible to the naked eye when tested. In other cases, they are not, and while it would seem plausible that the visible ones were more dangerous, yet, to my mind, the hidden danger due to the ones that are hard to see is a matter that must not be overlooked. For many years, the dangerous defects in steel rails have been those which were not visible and which have usually been very small at the start. During the war, when the demand for gun steel was very heavy, flaky steel, so called, was the material that gave the government the greatest cause for concern. In fact, those who are best posted on the metallurgy of steel are paying more and more attention to the minor defects, which heretofore have been considered but of little importance. This is equally true in a case of welds and in finding out what a welder can do, this is one of the things that should be examined most carefully. A method for testing rails for these hidden defects has recently been developed by F. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hack saw, machined or filed to a true surface, and polished on various grades of emery paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from a half an hour to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. It is not really necessary to warm the acid, although it takes longer when it is cold. The bending test, hot and cold, and the etching test are of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately what the quality of the work done by the different welders is.

Effects of Strain

Some of the defects in welds are visible under the microscope, but others are not visible until the weld is strained. A small bending machine that can be placed on the microscope stage is very useful, because after etching, the piece can be bent and examined to see what the effect of the strain is. In the case of bare wire electric welds, the rupture, as far as my experience goes, always occurs at the grain boundaries, even where no defects are visible there at the highest powers of the microscope. Of course, where there are visible defects, the rupture takes place first at these. Where there are no defects, the distortion occurs by slipping in the grains as in normal steel. The causes of these defects are to my mind almost always oxides of one or another constituent of the metal, but usually of iron. There is no positive proof of this as yet, but there are indirect proofs. An electric weld that will bend very little may be made much more ductile by heating in a reducing atmosphere at a low red heat for one or two hours, indicating that the weakness at the grain boundaries has been removed. The reducing atmosphere would seem to make it clear that the material at the grain boundaries was on oxide. Again, heating an electric weld in an oxidizing atmosphere makes it more brittle.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating stress tests.

Conclusion

A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds, but after they have been seen a number of times, an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly welded. The appearance of properly made electric welds has been well described by Mr. Escholtz of the Westinghouse Company and has been published in several of the trade journals. The appearance in a gas weld of porosities on top, indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger tip than is necessary to produce thorough fusion. This means than the catalogue speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material which has been seriously overheated should be more brittle and weaker than the material which has been properly melted. I have found in a number of cases that very great improvements in the quality of the work were made by using regularly a bending test, and by carefully instructing the welders until their welds meet this test with unfailing regularity.

Labor Saving Devices on the Santa Fe*

Several Effective Methods of Holding and Machining Various Locomotive Parts Are Described in Detail

BY J. ROBERT PHELPS

Apprentice Instructor, Atchison, Topeka & Santa Fe, San Bernardino, Cal.

With the present high cost of labor, it is important that every possible effort be made to simplify shop operations and increase the output. One of the best methods of accomplishing this result is to design and install efficient jigs and fixtures wherever possible, thus saving time and in many cases affording more accurate work. The following comparatively simple shop devices have worked out well at San Bernardino:

Drilling Steam Pipe Casings

Much difficulty is sometimes experienced in drilling the connection bolt holes in steam pipe casings. If the attempt is made to hold the casing on a block of wood with one hand and operate the drill lever with the other, there is a considerable chance of either the block or casing slipping with possible injury to the operator or breakage of the drill. The jig illustrated in Fig. 1 has proved both simple and convenient for this work. It consists of a framework of 1½ in.

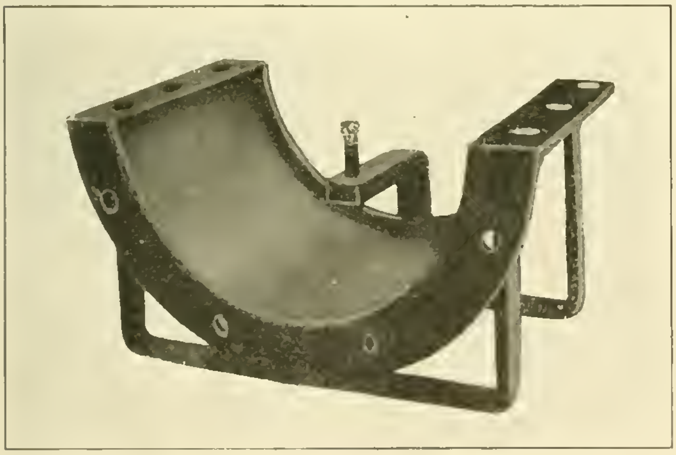


Fig. 1—Jig for Holding Steam Pipe Casings

by ½ in. iron built up by bending and electric welding and arranged to rest squarely on the drill table. It is fastened to the drill table by a ¾ in. by 2½ in. bolt and supports the steam pipe casing in the proper position for drilling. A set screw is provided to hold the casing in place. This device eliminates all blocks, bolts and clamps and is a big time saver, as the casing to be drilled needs no leveling and is quickly applied and removed.

Machining Eccentric Blade Jaws

A device which has proved useful in machining eccentric blade jaws is shown in Fig. 2. It is especially useful when the inside jaws have become worn and are built up by gas or electric welding to take up lateral play. An eccentric blade is shown in Fig. 2, set up on a millling machine table. Referring to the illustration, the Arbor *A* is turned to the standard taper of the eccentric blade pin holes, namely, ¾ in. in 12 in. The eccentric blade is set up and securely fastened to the milling machine table so that the arbor is level and square with the table. The boring bar *B*, shown in detail in Fig. 3, is provided with a cutter *C*, held in place by set screw *D*. After the blade has been securely clamped in the correct position, the arbor is removed from the eccentric blade jaws. The boring bar is placed through one side of the pin hole and both inside faces are machined with the

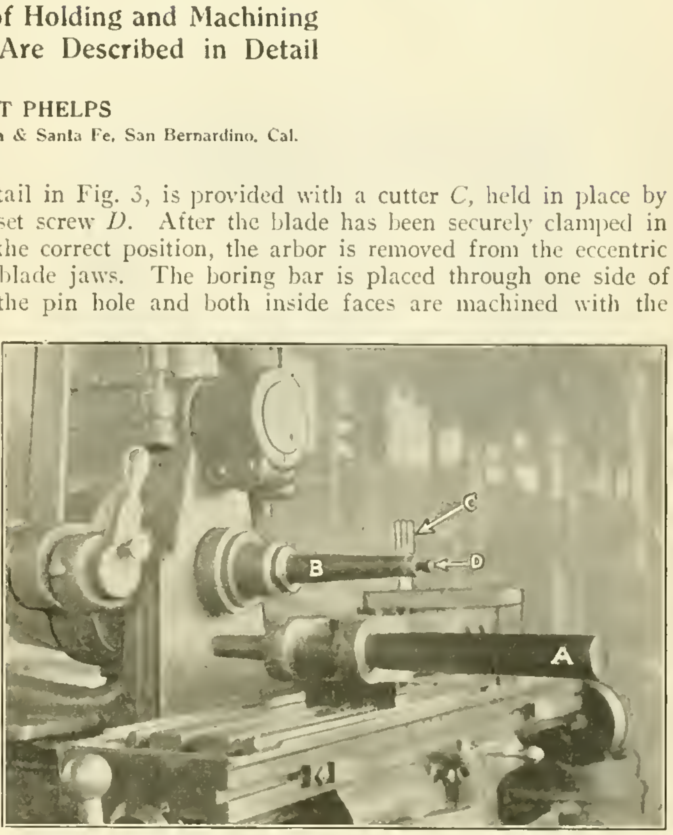


Fig. 2—Eccentric Blade Set Up on Milling Machine

double acting cutter fastened in the boring bar. In addition to getting a smooth, accurate job by this method, there is a big saving in time over the former method of performing the operation on a slotting machine. To care for eccentric

Fig. 3—Details of Boring Bars for Light and Heavy Work

blades with non-standard taper two additional arbors are provided with tapers of ⅜ in. in 12 in. and ½ in. in 10 in., respectively.

Boring Cylinder Bushings

It may sometimes be necessary to bore high pressure cylinder bushings in a lathe and for this operation some holding device must be employed. An arrangement of four iron bars, provided with set screws, and placed in wooden blocks, as shown in Fig. 4, has been found effective. The blocks are securely fastened together by iron straps and the cylinder is adjusted and held in place by the set screws. Previous practice was to bore blocks to the exact bushing size, place

*The first article written on this subject by Mr. Phelps appeared on page 721 of the November *Railway Mechanical Engineer* and described five efficient jigs and fixtures in use at the San Bernardino shops.

the bushing in the hole and clamp down the block. This practice made it necessary to have seven or eight different sizes of blocks and every time a set became warped or a bushing varied in size, new blocks were required. By the use of the jig illustrated one set of blocks will hold every size of high pressure cylinder bushing in stock. As the bushings are now cast about eight inches shorter and without flanges, there is a saving of three hours' time and 90 lb. of cast iron on every high pressure cylinder bushing.

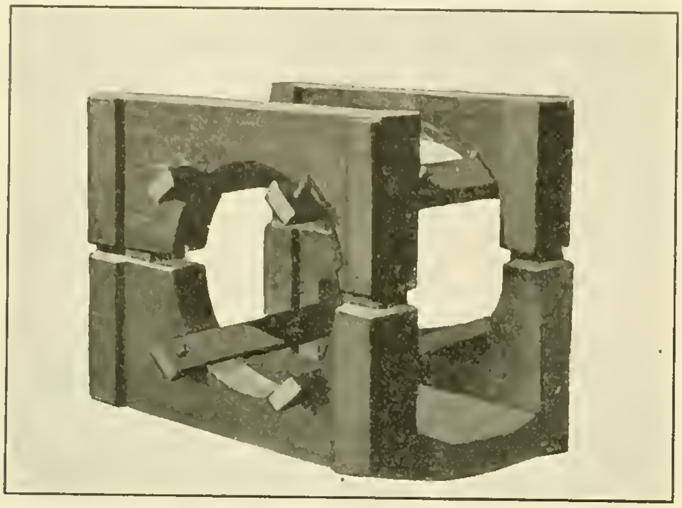


Fig. 4—Device for Holding Cylinder Bushings in Lathe While Boring

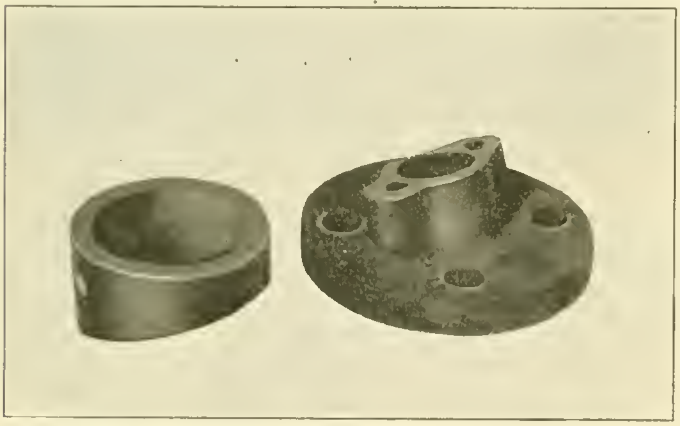


Fig. 5—Throttle Rod Stuffing Box and Jig Used in Drilling Stud Holes

Drilling Stuffing Box Stud Holes

An arrangement for holding throttle rod stuffing boxes while drilling the two stud holes is shown in Figs. 5 and 6. Owing to the slant or angle of the flange, a large amount of leveling and blocking is necessary to get the stuffing box face level; not only that, but the blocking in many cases slips out and all the time spent in leveling has been wasted. Where many stuffing boxes have to be drilled, it will certainly pay to make a special jig for holding them. The jig may be made of cast iron or brass. As shown in Fig. 6, it consists of a bushing or piece of tubing just large enough to slip on over the ball joint of the stuffing box. The bushing is cut off to a taper or angle corresponding to that of the stuffing box, an arrangement which brings the stuffing box face horizontal ready for drilling. The stuffing box cannot slide off, being held by its projecting ball joint and the entire arrangement can be held firmly to the drill table by one clamp and with no clumsy blocking.

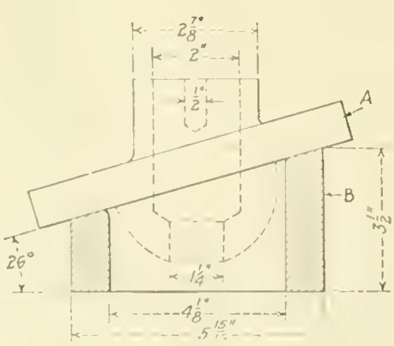


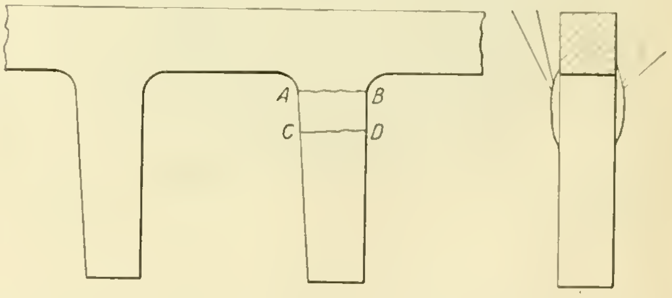
Fig. 6—Stuffing Box Set Up Ready for Drilling

BROKEN THERMIT WELD

BY J. D. SMITH

One of the back pedestal legs of a locomotive was broken at an old Thermit weld, and it was decided to repair the frame by making a new Thermit weld. It was necessary to cut out a block of steel from the leg as shown at *ABCD* in the illustration, the distance *AC* being about 3 in. and the total volume of metal removed about 48 cu. in. The surfaces *AB* and *CD* were chipped flat and parallel to the top of the frame. The Thermit box was assembled around the break and risers taken off at the inside and outside of the frame.

After the job was finished and the engine returned to service, within a few days the weld broke along the line *AB*. Upon examination of the fractured surface, it was found that the Thermit steel had not united firmly with the frame. About one-half of the area was composed of slag and blow holes; the slag, being lighter than the steel, rose to the top, and there coming into contact with a flat horizontal surface, did not all escape up the riser when the heat was poured. The other half was of a very coarse crystalline nature, brittle and easily chipped. It had the appearance of the fracture of a bar of nickel. This was probably due to the fact that the free nickel and the manganese content in the Thermit had not been properly diffused throughout the steel at the time of tapping the crucible. It was probable that the crucible was tapped before the reaction was complete. The mold was pre-heated in the usual manner, but the pre-heating was not carried so far as to bring the chipped surfaces of the frame to the fusing temperature.



Position of Weld on Pedestal Jaw

It seems reasonable to assume that had the surface *AB* been faced off at an angle with the top of the frame instead of parallel to it, and the riser taken off at the highest point, the accumulation of slag would have been avoided, as there would have been no tendency to lodge under the frame, and a better weld obtained. Along the surface *CD*, the weld was perfect, showing that the hot Thermit steel striking that part first, had thoroughly united with it. The breakage of this weld shows the importance of thorough pre-heating of the surfaces, and of allowing the reaction in the crucible to become completed before tapping. In a larger weld, the conditions are somewhat different, as a large volume of liquid steel is employed and the rate of cooling after pre-heating less.

Modernizing the Railway Power Plant

Superheated Steam and Other Means Needed to Improve Stationary Plant Capacity and Efficiency

BY R. A. HOLME

Locomotive Superheater Company

THE railroads of this country for their locomotives and stationary power plants use approximately 180,000,000 tons of coal per year, of which 20,000,000 tons, as nearly as can be estimated, are consumed by the railway stationary power plants. Figuring coal conservatively at $3.50 per ton, the value of the coal consumed in stationary power plants of the railroads for one year is $70,000,000. This enormous expense should be reduced, and with the application of possible and practical ways and means, worth while savings can be effected.

The average railway stationary power plant is subject to improvement, because outside of a few of the larger shops, equipment of old and antiquated design is being used in the smaller plants. Railway men agree that little attention has been paid to efficiency in the operation of their stationary power plants. There are many ways in which fuel can be saved in these plants. The skill and carefulness of engineers and firemen can be increased, but with the constant changes in the class of labor available, the scarcity of labor and its high wage, it is an exceedingly difficult matter to effect improvements by methods that involve the human factor.

The Government Fuel Administration as well as the Fuel Conservation Section of the Railroad Administration did an inestimable amount of good educational work among the personnel of railway officials. Great improvements resulted from these efforts, but in order to be effective this work must be continued indefinitely.

Stationary Plants Must Be Modernized

We must do more, however, than make the best of the equipment that is being used. The plants now in operation must be modernized by the installation of practical modern devices which lead to a positive increase in economy. These devices should be as far as possible inherently automatic. The utilization of modern and efficient devices will give positive and continuous improvement in fuel economy, whereas old and antiquated plants require continual expenditures to be kept in a reasonably efficient condition. The design of machinery and equipment predetermines the efficiency of a power plant. An incorrectly and poorly designed plant can never be made economical, regardless of how intelligently it is operated. It is essential therefore that all new plants built in the future be designed to give the most economical results, both in the use of fuel as well as in the training of labor.

Modern superheater equipment as applied to stationary plants should show an average saving of 15 per cent in fuel. In a 1,000 h.p. plant using 50 tons of coal a day at $5 a ton, this saving would amount to about $14,000 a year. This saving will not only pay for the charges against the investment, but will leave a substantial margin of profit.

Careful consideration should be given to the design and construction of the baffles which form the passage for the hot gases. Leaky baffles result in great waste.

The question of keeping the boilers clean is important and the installation of soot blowers can be made at a very moderate cost. Boilers should also be kept clean internally to prevent the failure of water tubes or boiler plates and to keep down the consumption of coal.

The proper amount of air required for burning the fuel dictates the correct use of dampers. A few railway plants are equipped with damper regulators and this equipment can be installed at a moderate cost. Another apparatus which results in improved efficiency and one seldom found in a railway plant is the feed regulator, which is a highly successful means toward improving the efficiency and operation of a plant.

The wonderful development in the design and construction of mechanical stokers now makes possible better regulation of the fire and higher economy by the installation of such equipment. Coal and ash handling equipment are improvements which are factors in modernizing the average railway stationary power plant, from which economy is derived.

Advisability of Using Superheated Steam

Superheating theoretically reduces the amount of fuel consumed from 6 to 15 per cent and actual tests have shown fuel saving of better than 20 per cent. Where the cost of fuel is high, therefore, superheating directly applied is a valuable and profitable investment.

The following is a comparison of the steam consumption of different types of engines using saturated steam (under average plant conditions) with those using superheated steam at 100 deg. and 200 deg. Fahr. superheat:—

Type engine	Steam consumption, lb. per hp. hr. — Saturated steam	100 deg. superheat	200 deg. superheat
Simple non-condensing	29-45	20-30	18-36
Simple non-condensing automatic	26-40	18-34	16-30
Simple non-condensing Corliss	26-35	18-30	.....
Compound non-condensing	19-28	15-25	13-22
Compound condensing	12-22	10-20	9-17
Simple duplex steam pumps	120-200	80-160	.....
Turbines, non-condensing (kw. hr.)	28-60	24-54	21-48
Turbines, condensing (kw. hr.)	12-42	10-38	9-34

The saving, of course, depends upon the efficiency of the engine itself, but it will be noted that in all cases superheating shows substantial steam economy. The percentage of saving varies from 9 to 33 per cent for 100 deg. superheat to from 19 to 38 per cent for 200 deg. superheat.

Another factor which should be taken into consideration in the modernizing of an existing plant by means of superheating is that of maintenance. The question of maintenance depends on the design and construction of the superheater installed. Under no circumstances should superheater equipment be installed until the existing conditions in a plant have been properly, carefully and thoroughly studied. Recommendations for superheater equipment can be made correctly only after such a study has been made. On these recommendations depend the degree of superheat which can be most advantageously used. In a properly designed superheater the maintenance of the superheater should be no higher than the maintenance of the boiler. It is well to bear in mind that the maintenance of the boiler itself is actually reduced when a superheater properly designed is installed, because superheating so increases the capacity of the boilers that in a battery of superheated boilers the added capacity may make it possible to periodically rest each of the boilers as the other boilers will still have sufficient capacity to carry the load economically. In a plant so designed and so equipped one boiler can be held in reserve, with the result that all of the boilers will last longer and their maintenance cost thereby be reduced.

The superheater equipment should be such that it can be easily maintained by the usual boiler room help and by the

use of such tools as are ordinarily found in the boiler room. It should not be necessary to go outside to secure skilled boiler makers to keep it in first-class operating condition.

Capacity an Important Factor

Not the least important of the factors which indicates the advisability of applying superheated steam is the question of boiler capacity which frequently faces railway officials. We have already seen that superheating decreases the steam consumption of the engine. This decrease may be attributed to the fact that superheating eliminates cylinder condensation, thereby insuring dry steam reaching the engine. With a decrease in steam consumption, due to superheating, a steam reserve is built up, which reserve is available and can be utilized in the engine to take care of its overload capacity, should an additional power demand be required.

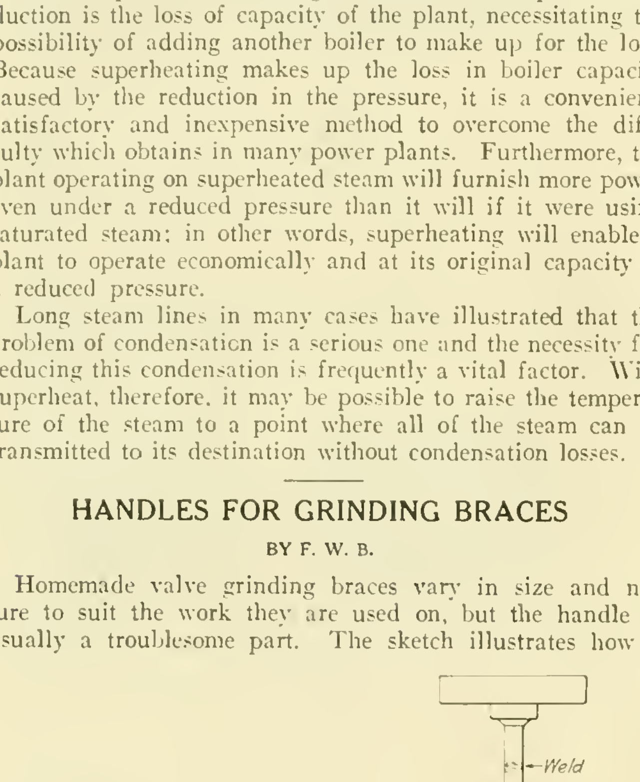
Another important factor to be considered is the course which must be pursued by the power plant operator if he is forced by boiler insurance companies to operate his boilers at a lower pressure. The logical result of such pressure reduction is the loss of capacity of the plant, necessitating the possibility of adding another boiler to make up for the loss. Because superheating makes up the loss in boiler capacity caused by the reduction in the pressure, it is a convenient, satisfactory and inexpensive method to overcome the difficulty which obtains in many power plants. Furthermore, the plant operating on superheated steam will furnish more power even under a reduced pressure than it will if it were using saturated steam; in other words, superheating will enable a plant to operate economically and at its original capacity at a reduced pressure.

Long steam lines in many cases have illustrated that the problem of condensation is a serious one and the necessity for reducing this condensation is frequently a vital factor. With superheat, therefore, it may be possible to raise the temperature of the steam to a point where all of the steam can be transmitted to its destination without condensation losses.

HANDLES FOR GRINDING BRACES

BY F. W. B.

Homemade valve grinding braces vary in size and nature to suit the work they are used on, but the handle is usually a troublesome part. The sketch illustrates how a



Grinding Brace Handle Made From Scrap Air Motor Piston

desirable handle can be made from a scrap air motor piston. Discarded pneumatic motor pistons are of all sizes and it is not much trouble to anneal a number of them, cut away some of the wing making a solid durable handle grip that will stay on and run smoothly. The end of the piston rod can be welded to the brace quickly with an acetylene torch.

HOW TO MAKE A GOOD CHISEL*

A large number of the chisels now in use are not forged, shaped and hardened in the best way to give long life and adequate service. Considering the making of a chisel from ¾-in. octagon tool steel, the following method has been found to give good results.

Forging

Cut off a length of steel, depending on the length of chisel desired, and heat up the end for 2 in. to a bright cherry red. Trim off two opposite sides so as to form a blunt nosed tool and eliminate the danger of lapping when drawing out. The horn of the anvil should be used in drawing out, inasmuch as this will have the least possible tendency to widen the piece, and therefore the minimum amount of "edging in" or hammering on the edge will be necessary. A chisel should not be hammered on the edge because the grain of the steel will thereby be distorted or "crumpled up," and this always has a tendency to weaken any metal. If in the final forging operation the chisel gets a little too wide, it can be trimmed off on the emery wheel during the grinding operation.

Draw the chisel out so that it will be about ⅛ in. thick

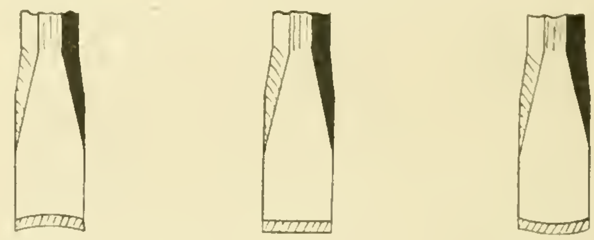


Fig. 1 Fig. 2 Fig. 3

Three Methods of Grinding Flat Chisels

at the end and about ⅜ in. thick and 1¼ in. back from the end. The forging should be finished with light blows until the steel has almost lost color, but it absolutely must not be struck after the color has disappeared. It is good practice to reheat the steel to a dull red without using any blast, and give it a second hammering with light blows until the color has again almost disappeared.

The four important things to remember in forging a chisel are, therefore: Draw out at a good cherry red heat; finish with light blows at a dull red heat; do not hammer after the color has disappeared; hammer as little as possible on the edge and then only when the steel is fairly hot.

Grinding

Grind the chisel before it is hardened, as it can be ground faster in this way without the danger of drawing the temper. The shape of the edge of the chisel is very important, although this fact is often overlooked. Fig. 1 shows a chisel ground with a concave edge. If this is driven down onto a flat surface, it is obvious that a great strain will be put on the corners, and they are almost sure to break off. Fig. 2 shows a chisel ground with a perfectly flat edge. If this chisel is driven down onto a flat surface and held perfectly straight the cutting strain will be distributed evenly over the entire edge, and the chisel will be satisfactory. It must be remembered, however, that it is almost impossible to hold a chisel absolutely straight and, therefore, either one corner or the other will be severely stressed by the chisel being tilted over. Fig. 3 shows a chisel ground with a slightly convex edge, which is by far the best for ordinary work. The corners of a chisel are always the danger point, and with the convex edge these

*Abstract of 4-page folder issued by Joseph T. Ryerson & Son, Chicago, Ill., entitled "Do You Know How to Make a Good Chisel?"

corners are protected even when the chisel is tilted over considerably to one side or the other.

Hardening and Tempering

After the chisel has been ground to the desired shape, heat it to a dull cherry red color for about 2½ in. from the end and quench it vertically in cold water to a depth of 1¼ in., moving it up and down until no red color is left in any part of the steel. The part which has been drawn out should now be polished with emery cloth and the temper drawn to a dark purple or a blue by holding the chisel over the fire or in a furnace. Always draw a chisel a little more in winter than in summer. It has been recommended to harden the chisel back much further than usual because a chisel so made can be ground a great many times without redressing. Inasmuch as grinding is cheap and redressing is expensive, considerable loss can thereby be avoided.

FOUR FRAME WELDS IN TWO OPERATIONS

An interesting example of the possibilities of Thermit welding was afforded recently by an accident which happened to Baltimore and Ohio locomotive No. 4010 used in hill service. While pushing a heavy train up grade all four

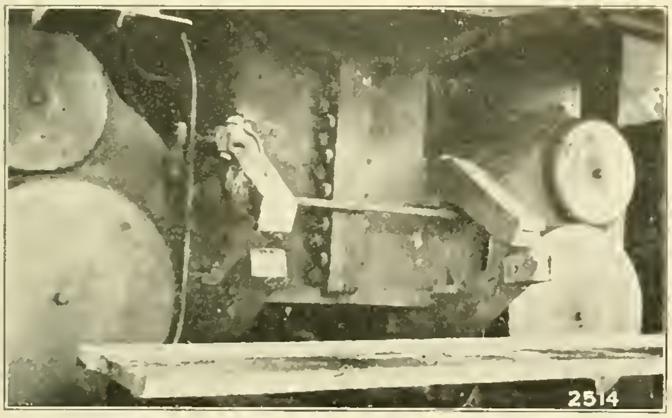


Fig. 1—Appearance of Front Frames Before Welding

front frame sections were broken in front of the cylinders as shown in Fig. 1.

In making repairs, the frames were straightened and the broken ends located in place ready for welding by the Thermit process. As the two pairs of fractures happened to be very

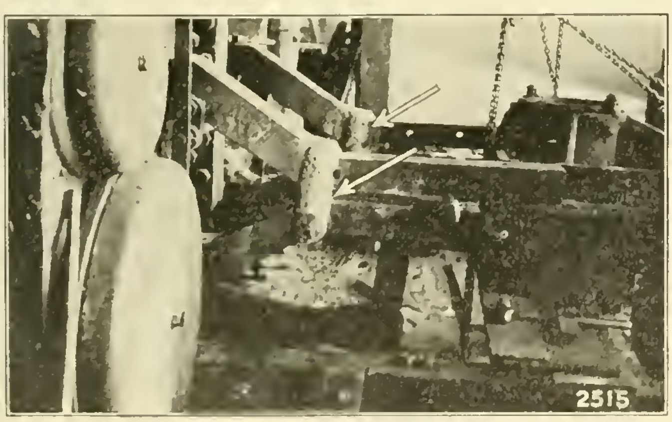
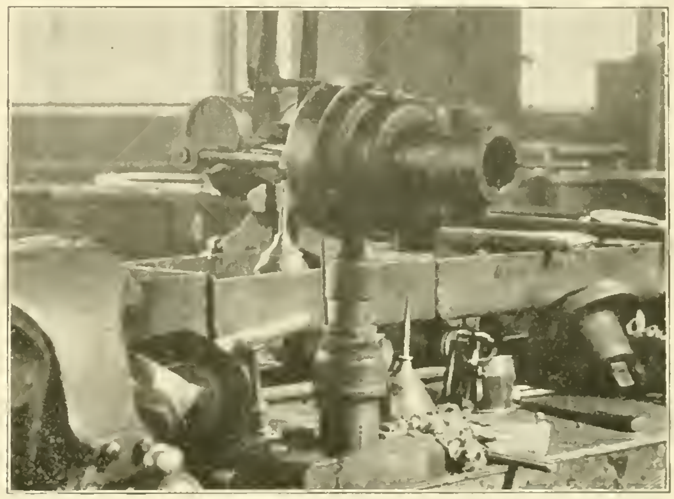


Fig. 2—View Showing Thermit Welds and Front Deck Casting Ready to Be Applied

close together, the top and bottom members of each set were repaired by making only one weld, thus joining both frames together as shown at the arrows in Fig. 2. The result was not only a saving in time, labor and material, but a strengthening of the frames at the points welded. After the welds were completed and the deck casting put in place, it was only necessary to ream out the holes and rebolt the casting. These welds were made by J. W. Boyd on April 6, 1920, and the locomotive has since been in constant service.

TRIPLE VALVE GRINDING MACHINE

The device illustrated was designed to eliminate the labor of grinding triple valve slide valves. As shown, the valve is arranged to be held on a stand on the air brake bench. The grinding compound is applied to the slide valve and it is then placed in position on the valve seat. An eccentric with a crank arm and crank is driven by means of a light



Triple Valve Grinding Machine

belt from overhead shafting. The crank arm is arranged to be connected to the slide valve and when power is applied, the valve will be moved back and forward.

When either the slide valve or its seat is badly worn, experience has shown that a long time is required to grind out the irregularities by hand. The slide valve grinding device illustrated has proved a labor-saver for this operation.

CARBON AND HIGH SPEED STEEL*

BY J. PURCELL
Western Pacific

When designing or making a tool from carbon steel we must first consider the proper kind of steel to use and then see that the tool is designed so that it will harden properly without breaking.

Too much cannot be said about the heating and forging of steel, as the heating of steel to forge is one of the most particular of all the operations. The tool dresser must turn the steel over in the forge or furnace to see that it is heatsd evenly to a little above the hardening temperature, say about 1,475 deg. to 1,500 deg. F. The tool dresser must bear in mind not to forge steel after the forging heat is gone, as the steel will develop small cracks and bad forging strains, which will cause it to crack in hardening.

I consider it good practice to first anneal the rough forging, then have it rough machined and then re-anneal it to take out all possible forging strains; then the tool must be machined to finished sizes. It is then ready for hardening.

In heating any ordinary carbon steel tool to harden, care must be taken not to apply heat too quickly, as this will result in cracking the tool while it is cooling in the hardening

*From a paper presented at the convention of the Master Blacksmiths' Association.

bath. A good practice is to have tools that you are going to harden placed around the forge fire, or, on top of the tool furnace, where they will become slightly heated before they are put into the fire. The tool must have time to heat to the center, otherwise it will crack when it is removed from the hardening bath. A good hardening heat for carbon steel is from 1,400 deg. to 1,450 deg. F.

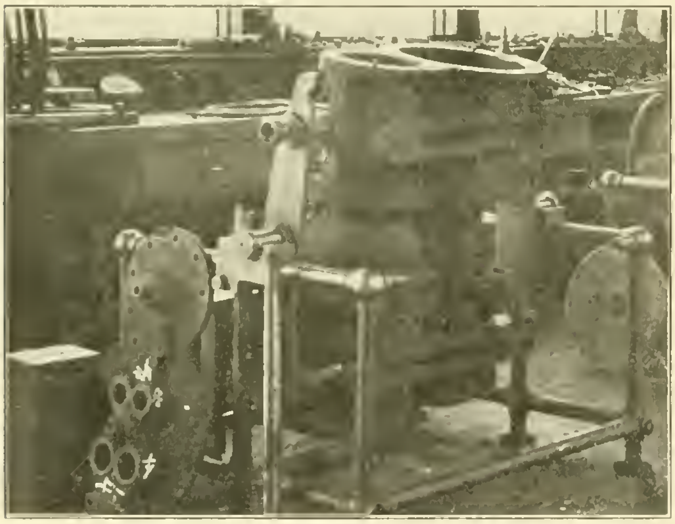
There are various ways to temper, but we use the oil and thermometer. The tool is placed in the bath of oil, which has a thermometer attached and the bath is placed in the furnace. The oil is brought up to the required temperature, the tools are removed from the oil and put into a vat containing lye to remove the oil, then quickly removed from the bath and allowed to cool in the open air. We draw the temper from 380 deg. to 590 deg. F., according to the amount of carbon in the steel.

The forging, hardening, and tempering of high speed steel is carried on by practically the same methods as carbon steel, except at a much higher temperature. We forge our high speed steel between 1,875 deg. and 1,925 deg., harden between 2,300 deg. and 2,350 deg. F., and let the temper down to about 600 deg. F.

AIR COMPRESSOR STAND

All shop men are familiar with the difficulty of handling air compressors, especially the heavy Westinghouse cross compound compressors. Many different kinds of tables or stands have been devised for holding them while under repair and the one illustrated has proved both simple in construction and efficient for this purpose.

As shown, the stand itself is composed of built up sections of pipe. Two iron brackets are arranged to be solidly fastened, one on either side of the compressor, by means of pipe studs in the air and steam intake and exhaust passages. On each bracket there is a projecting center arranged so that



Stand Arranged to Swivel Air Compressor

both the compressor and brackets will be suspended at the center of gravity of the compressor. By this means, a compresson can be easily swiveled at any angle, or upside down, whichever position is most convenient for the workman. Dogs are arranged to hold the compressor firmly in either the horizontal or vertical position.

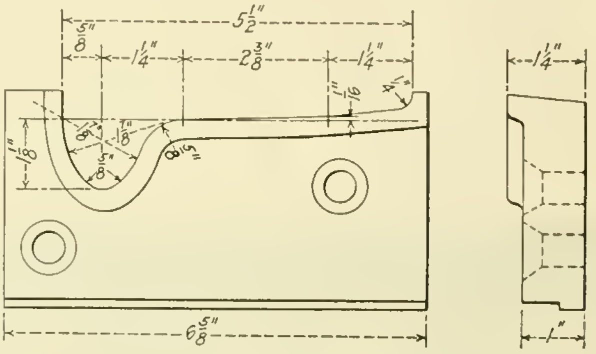
In operation, the compressor is first thoroughly cleaned and the brackets put in place. A monorail crane then lifts the compressor and brackets, setting them down at whatever compressor stand may be vacant. In this way, practically no trucking by hand is required and there is a big saving in labor.

HEAT TREATMENT OF FORMING TOOLS FOR WHEEL LATHES

BY FRANK D. KENNEY
Toolmaker, Billerica Shops, Boston & Maine

There are a great many factors to be considered in explaining why a certain tool does extraordinarily good work. When all other factors remain constant and the tool efficiency is improved by changes in heat treatment, it is possible to arrive at a point where breakage is practically eliminated and the tool does its greatest amount of work. The heat treatment directly responsible for such a tool is of more than passing interest.

Wheel lathe forming tools giving the maximum amount of service at Billerica Shops are made of a well-known brand of high speed steel. They are about 6 in. long, 4 in. wide



Wheel Lathe Forming Tool

and 1½ in. thick. On one of the 6 in. sides, a profile of the tread and flange of the tire is milled. The other long side is shouldered in about ¼ in. leaving a square rib on the lower edge which fits into a slot on the tool post. Two holes are drilled in the proper places to allow for bolting to the machine.

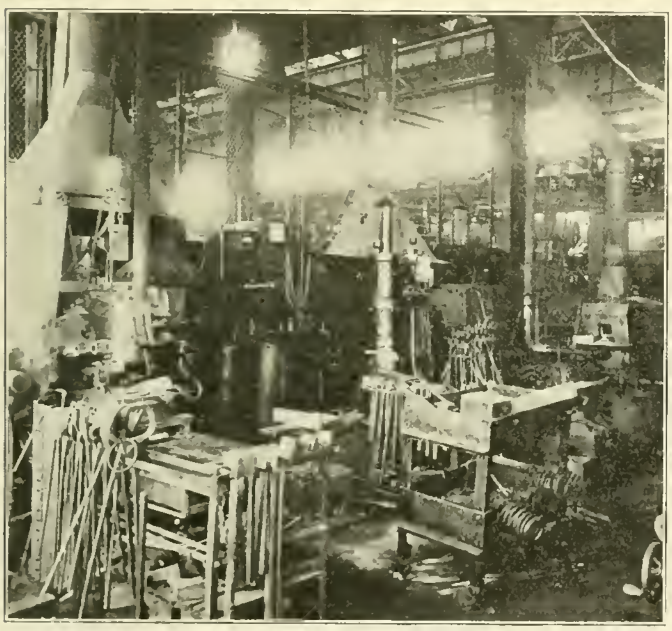
For the heat treatment of these tools, the one thing that is necessary is equipment. Not necessarily expensive equipment but efficient equipment must be provided if it is desired to obtain good results, and duplicate them to any degree of accuracy. For heat treating forming tools, four crude oil-fired furnaces, pyrometers, thermometers, etc., are used. The larger of the furnaces is held at a heat of from 1,400 deg. F. to 1,450 deg. F. and used for carbon steel; also for pre-heating high speed steel. Adjacent to this is the high heat furnace for the hardening of high speed steel, held between 2,250 deg. F. and 2,300 deg. F. Then there is the lead bath which is held at about 750 deg. F, and used for both quenching and drawing forming tools among other operations. Finally there is the tempering furnace used in drawing operations up to 600 deg. F.

Forming tools come to the tool room for treatment in pairs, a right and a left. They are laid on the roof of the carbon steel furnace and left there until too hot to handle with the hands. They are then removed to just inside the door of the 1,450 deg. F. furnace, which spot happens to be the coolest place within the oven. After becoming warm, they are gradually worked toward the center of the furnace. When the steel becomes thoroughly heated to the temperature of the oven, the tools are ready for the high heat. They are placed in the 2,300 deg. F. furnace one at a time, each tool being constantly watched and frequently turned and moved about to insure uniform heating. When the last "shadow" has left the center of the tool, and the surface looks glossy and wet, and when little bubbles seem about to form, or in other words when the tool attains the proper hardening temperature, it is removed and placed in the lead bath which has been previously heated to 750 deg. F. and quenched therein.

On account of the lead having a higher specific gravity than steel, the tool must be weighted to keep it wholly immersed in the bath. This is done for the want of a better way, by means of a heavy block of iron long enough so that one end rests on the edge of the pot and the other on the tool which is dipped endwise. This added weight keeps the tool covered with lead. The use of the lead as a quenching medium positively eliminates breakage, a fact which in itself is reason enough for its use. The second tool which was left in the 1,500 deg. F. oven goes through the same operation and both are left to cool to the temperature of the lead.

In drawing, we take advantage of that phenomenon in high speed steel treating known as secondary hardness or the 1,100 deg. F. draw. The pot is heated slowly to between 1,050 deg. F. and 1,100 deg. F., and the tools are allowed to soak at this temperature ten or fifteen minutes, after which they are removed and allowed to cool naturally. Care must be taken not to heat the tools about 1,100 deg. F., as beyond this point there is a sharp loss of high speed steel's greatest asset, that of red hardness.

The one bad feature of lead as a quenching medium is the fact that it has a tendency to stick to the work with the resultant glazing of emery wheels and trouble in general trying to get it off. This can be overcome to a great extent by using



Heat Treating Corner of Toolroom

a piece of oily waste which, if rubbed briskly over the tool immediately after leaving the bath, will remove most of the lead. The two points of the operation that must be most carefully observed are the above mentioned caution of not drawing above 1,100 deg. F., and the temperature at which the tools are quenched. Subsequent operations all depend on the quenching temperature and, of course, are of no value without the proper hardening to begin with.

In regard to the 1,100 deg. F. drawing temperature, some very definite conclusions may be drawn from a paper prepared by the chief metallurgist of a leading machine tool manufacturer. From each of twelve different brands of high speed steel used in a test, four milling cutters were made. These were all heated and quenched alike (heated to 2,300 deg. F. and quenched in oil at 100 deg. F.). Two of the cutters from each brand were drawn to 450 deg. F., and the remaining duplicate set was drawn to 1,100 deg. F. A comparison of the hardness numbers made before and after the 1,100 deg. F. draw showed that two of the steels actually gained in hardness. Probably the most valuable data given was that made while the tools were checked under actual working conditions, which is in the last analysis the only real test of a tool. Tools drawn to 1,100 deg. F. in every case gave greater production than the ones drawn to 450 deg. F., and in some cases two or three times as much. These final phases of the experiment prove conclusively the great value of secondary hardness.

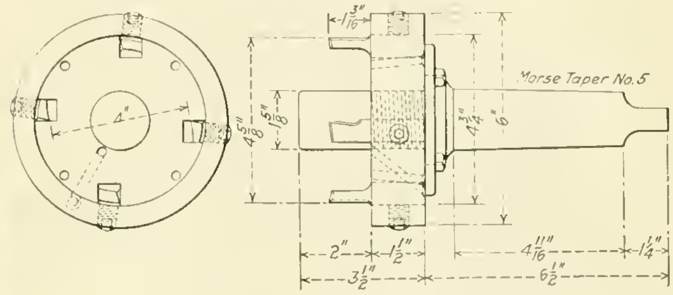
FLUE HOLE CUTTER

BY A. G. JOHNSON

Mech. Engr., D. & I. R., Two Harbors, Minn.

The illustrations show a special cutter used to make holes in firebox flue sheets for superheater flues. It is also adaptable to cutting holes in front flue sheets which, however, seldom need to be renewed. The cutter is used in a heavy drill press or radial drill.

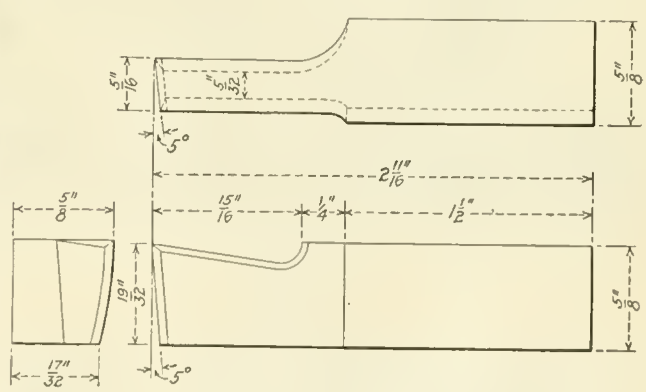
The shank is turned to a number five Morse taper and the



Assembled Flue Hole Cutter

guiding end is made of tempered tool steel. The center piece is a piece of soft steel, screwed onto the shank. Square slots are milled so that the cutting edges of the tools will come exactly on the center lines. The finished ring is shrunk on, then drilled and tapped for the safety set screws.

The cutters, which are made of ⅝ in. square tool steel, are held in place by the safety set screws shown and a plate is fastened on the back to prevent them from coming out. The tools are now dressed up on the grinding wheel and turned inside and out, with the grinder, to the exact size circle

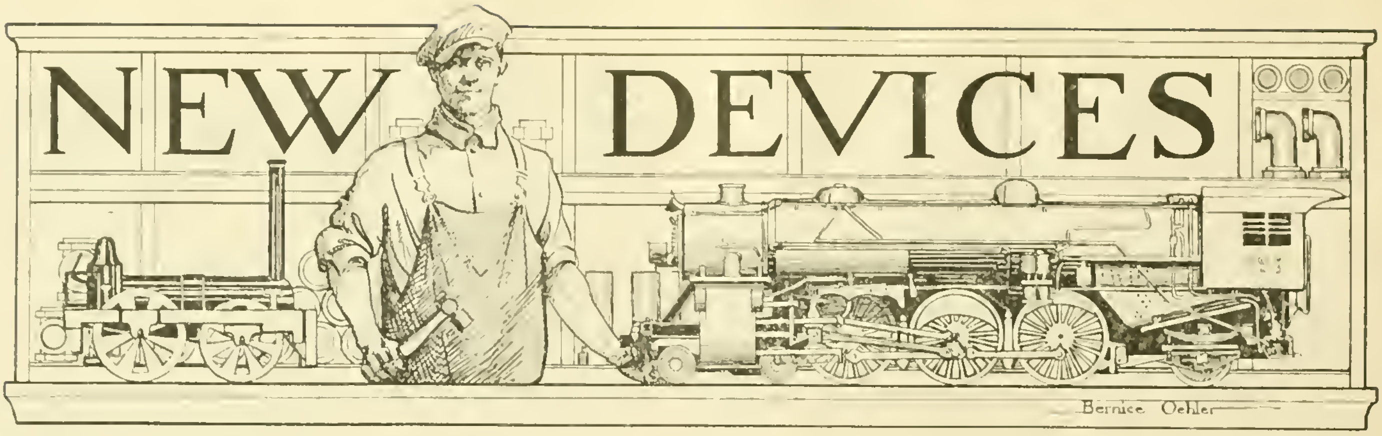


Sketch Showing Cutter Details

required. It will be noted that two tools are ground to cut on the outside and the remaining two are ground to cut on the inside so each continuously leaves clearance for the other, which makes a smooth job. Oil holes are put in, one for each tool and one for the center pin.

In operation the sheet is first layed out and flanged, the centers for flue holes being drilled 1⅝ in. in diameter to guide the cutters. Finished holes are cut in the sheet, at the rate of one every five minutes, through a ½ in. sheet.

One hundred and ninety holes have been cut through ½ in. plates with one set of tools without regrinding.



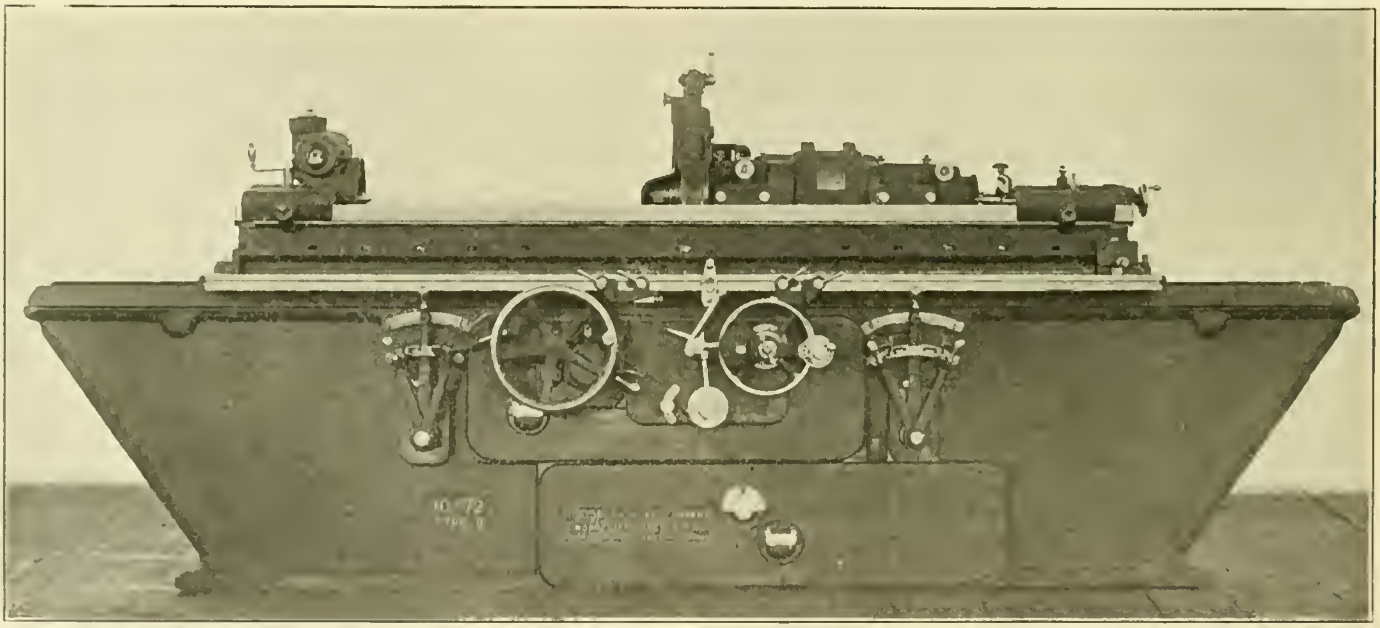
Self-Contained Cylindrical Grinding Machine

A NEW cylindrical grinding machine developed by the Norton Company, Worcester, Mass., embodies two important departures from previous practice. The new machine, known as the 10-in. by 72-in. Type B grinder, is entirely self-contained, being arranged for electric motor drive with the motor an integral part of the machine. This eliminates all overhead shafting and belts. The second noteworthy feature is the table speed obtained. In the past, it has been difficult to obtain a table speed of over 10 ft. per min. but by means of a patented reversing mechanism which reduces the shock and noise at reversal, the new Norton grinder provides table speeds from 10 to 32 ft. per min.

The head stock work drive is by means of spiral and worm gearing entirely enclosed in oil. The rotation of the work is started or stopped simultaneously with the table or alone by the use of a quick-acting lever and a multiple disc clutch. The footstock of the grinder is of improved construction combining the screw and lever types. Adjustment for the spindle fit can be made over its entire length at any time.

The wheel head or wheel slide is of massive construction and hollow containing a chain-driven pump and oil reservoir for oiling the wheel spindle and end thrust bearings. The oil supply to the spindle bearings is visible through two glasses in front of the operator. The spindle bearing adjustment is simple and the operator can cause the bearings to close tight upon the oil film on the spindle by simply turning the thumb screws until he cannot turn them any more. This adjustment is made at any time while the spindle is running. The end thrust also is adjusted by a thumb screw.

The spindle is driven by a belt from the power shaft enclosed in the base. Owing to the belt pull being downward instead of up, it is possible to transmit a greater amount of power to the wheel spindle than in former drives. An idler is provided to take up slack in the belt.



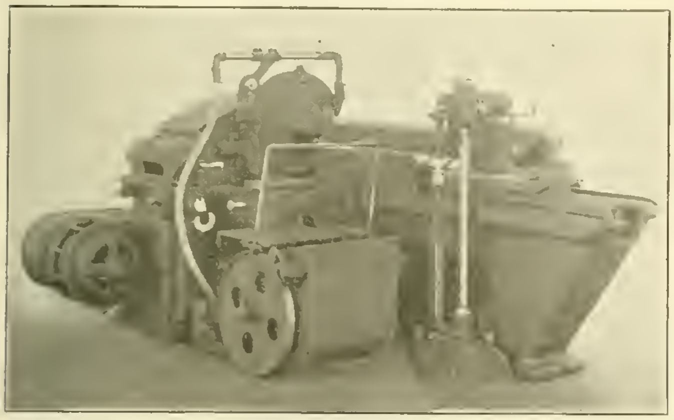
Norton Type B Cylindrical Grinding Machine of 10-In. by 72-In. Capacity

The work table is of improved construction to secure neatness in the care of the grinding compound. The sliding table is started and stopped either simultaneously with the work or separately as desired. The speed changes for the table are transmitted by means of heat-treated sliding gears and positive clutches in an oil bath. There is an independent table speed for truing the wheel which is obtained by moving a lever for this purpose only. The proper speed is obtained at once regardless of which work traverse speed may be in gear and is returned to the original table speed by moving the same lever back.

A quick-acting hand cross traverse for the wheel slide

and an improved micrometer adjustment for sizing work are provided. The in-feed is operated either at each end of the table stroke, or when the table is still for a direct in-cut. The change is made by the simple movement of a lever.

The pump tank and settling tank are integral, mounted

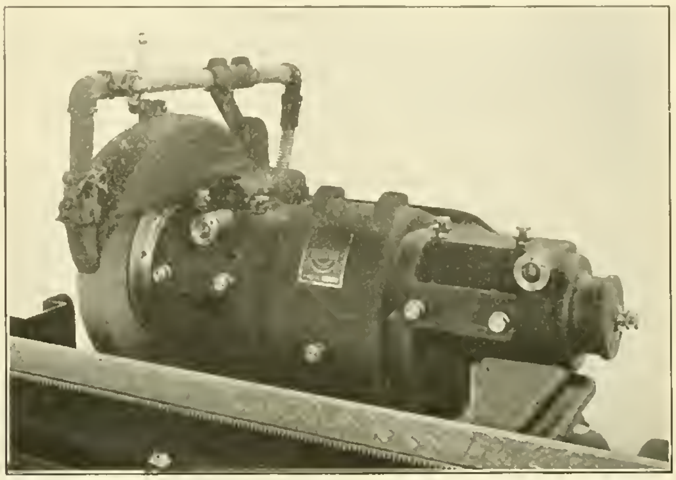


Rear View of Grinder Showing Setting Tank, Headstock Drive Mechanism and Driving Motor

upon ball-bearing truck wheels, so that the tank is in reality a dump cart on wheels. The pump is arranged to swivel on its driving-shaft axis and can be swung up out of the tank and the tank removed to dump while a duplicate filled with clean compound is rolled into place. The time required for changing the tank is only from three to five minutes. The steadyrests are of improved construction. They have thumb-screw stop adjustment for size of work and are attached or detached quickly by a lever and cam. The work shoes and work-shoe holders are interchangeable with previous types of Norton grinding machines.

Special attention has been paid, in the designing of the machine, to the lubrication of bearings. With the exception of a few places where it is not essential that the oiling be frequent, all the bearings are automatically oiled. There are also 47 ball bearings throughout the machine, all of which are enclosed in oil baths.

Six work speeds are provided ranging from 53 to 167 r. p. m. There are seven speeds for the work table. A truing speed of 2.3 ft. per min. can be obtained and regular speeds vary from 10 to 32 ft. per min. The length of the table is 8 ft. 10¾ in. Cylindrical work 72 in. long and up to 10 in. in diameter can be ground. Each tooth in the

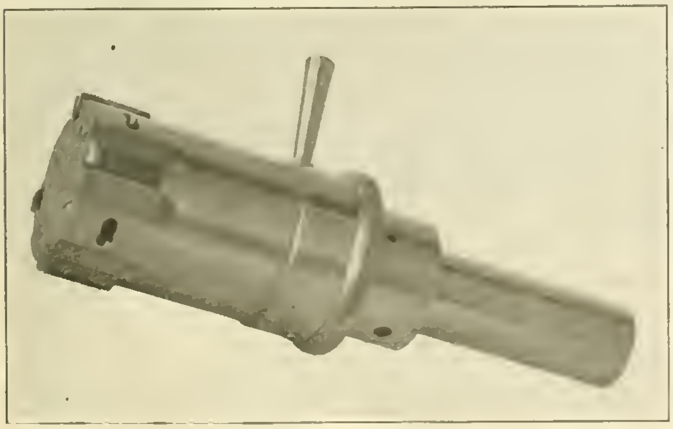


View of Wheel-head Showing Bearing Adjustment Screws

index gear represents a work diameter reduction of .00025 in. and there is an automatic feed range from .00025 to .0035 in. diameter reduction at each reversal of the table. A 15-hp. motor, designed to operate at a constant speed of 1,200 r. p. m., is required to drive the new Norton grinder.

Collapsible Tap of Simple Rugged Design

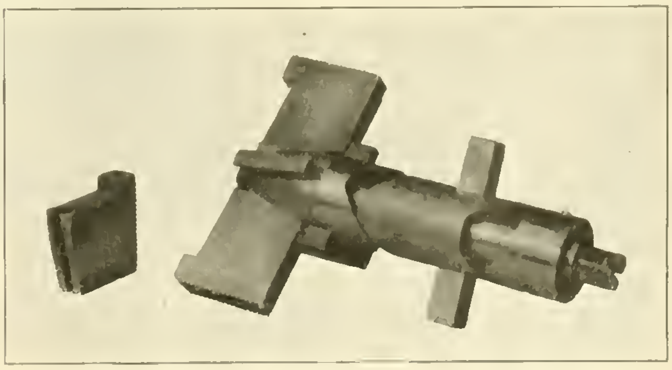
The original and outstanding feature of the new collapsible tap, made by the Rickert-Shafer Company, Erie, Pa., is the method of withdrawing the chasers when the work has been tapped to the required depth. The manufacturers claim it to be positive in action, inasmuch



Rickert-Shafer Collapsible Tap

as it is impossible for it to stick. This is a decided advantage in all cases, but especially so where work has to be tapped close to the bottom of the hole, in which case the operator can place full reliance upon the tool, as it is stated that the chasers will be released at exactly the right point.

The illustrations show the manner in which this is accomplished. At the point of release the force of the cut pulls the head from the locking pins and revolves it. This action causes the cams on the core to act and pull the core back, drawing the chasers in the head and clearing them from the



View Showing Mechanical Details of Collapsible Tap

work. It will be seen that in this tool no dependence is placed upon springs for the purpose of collapsing.

Attention is also directed to the method of making adjustments, which allows these to be made to the fractional thousandths. A guarantee accompanies these taps that they will

hold to size, within the most exacting limits, and that sizing hand taps can absolutely be dispensed with.

These tools have hardened and ground wearing parts and scientifically accurate chasers. They are manufactured in sizes from 1 in. to 10 in., or larger, and can also be combined with boring, reaming or chamfering tools, thus greatly increasing production by eliminating additional operations and set-ups.

Heavy Duty Continuous Milling Machine

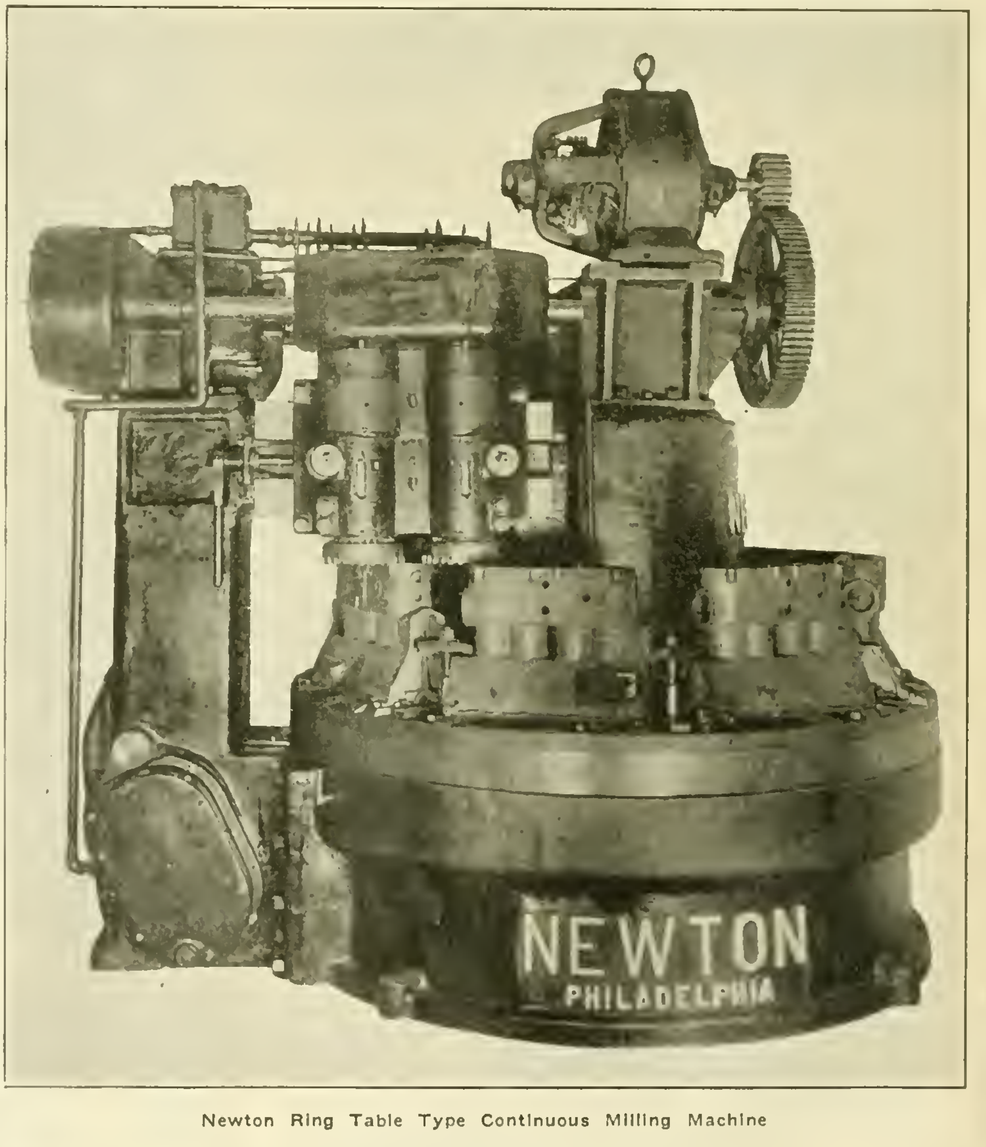
THE continuous milling machine of the ring table type illustrated herewith has been developed by the Newton Machine Tool Works, Inc., Philadelphia, Pa. The base of the machine is circular in form, providing a central taper column. The table casting is fitted to the central taper column of the base, and in addition is provided with an annular bearing close to the periphery of the table. The cross rail and the central upright are made in one piece so as to reduce the number of bolted connections.

The machine table is 84 in. in diameter and the depth from the annular bearing to the top of the table is 12 in. The least diameter of the taper fit between base column and table is 36 in. The table is provided with a finished hub 42 in. in diameter to assist in locating jigs on the table. The central column is bolted and keyed to the base and the cross rail is fitted in the front with one housing containing two spindles for the roughing cut. On the back of the cross rail and at a distance of 42 in. is a similar housing carrying a single spindle for the finishing cut.

Both housings for the roughing and finishing spindles can be positioned on the cross rail so that, where the machine is used for a variety of work, the spindles can be positioned to the most economical location of the jigs upon the table. The outer end of the cross rail is supported by a column which is bolted and doweled to the base as well as the cross rail. Motor drive is provided on top of the machine, the motor being geared to a jackshaft. At the extreme outer end of the cross rail there is a box used to transmit the motion from the jackshaft to the roughing and finishing spindles. This permits of varying the rotative speed of the spindles independently of each other and, while the speed is predetermined and fixed, this provision permits of changing the speeds when the grade of material or size of cutters is changed, a necessary feature if the maximum efficiency of cutting tools is to be utilized.

The rotative movement of the table is controlled by a fixed feed which is predetermined, but can be changed to suit any change in the grade of material. There is not, however, any possibility of the operator increasing or decreasing the production of the machine as the rotative speed has been predetermined. This means that a given number of stations per hour must pass the loading station, hence that number of pieces must be machined or require an explanation.

The table itself is rotated by a herringbone gear 81 in. in diameter. Each of the spindles is provided with an individual adjustment for setting the cutters to gages. Different sizes of housings providing varying centers between the roughing spindles are used, depending upon the dimensions of the work. Generally, however, these centers are either 12 in. or 14 in. Both spindles are rotated inward or clockwise on the left hand spindle and counter clockwise on the right hand spindle.



Newton Ring Table Type Continuous Milling Machine

With the distance of 42 in. from the center of the roughing cutters to the center of the finishing cutters, it is quite clear that the roughing operation has been performed on a given casting before the finishing operation commences, hence the finishing cutter is relieved of any influence on the part of the roughing operation and, due to the slight cut taken by the finishing cutter, any inaccuracy resulting from either dull roughing cutters or inequality of castings is picked up by the

finishing cutter, insuring accuracy of both finish and dimension. The principle of roughing and finishing cuts permits of operating at much higher cutting speeds and table feeds than is practical by any other process of surfacing operations.

All bearings, except the spindle bearings, are oiled by the cascade method of lubrication. Oil is pumped from a reservoir in the outer upright to the box on top of the machine, from which point it is distributed.

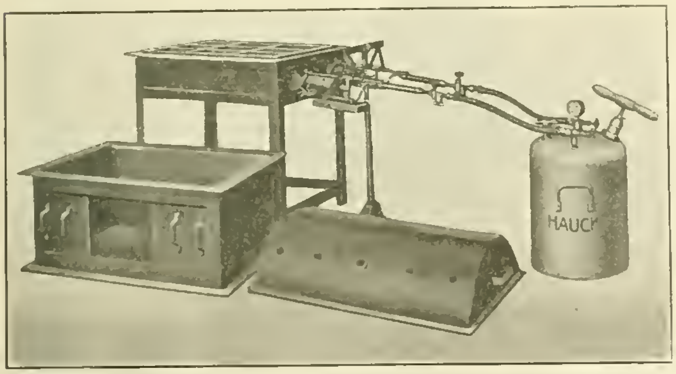
An important element is the extreme ruggedness of all operating parts and an excessive amount of weight is provided in view of the fact that the parts machined are quite incapable of absorbing any of the vibration set up by all cutting actions. The machine is designed to absorb and dissipate such vibration. The character of the work usually presented to these machines does not require a great range of adjustment, hence with the standardized model, this is taken up, first, by the adjustment in the spindle heads and second, by variation in the height of the jigs themselves.

The work presents itself to the cutters at varying angles providing that shearing action which it is recognized gives the best cutting results. Also the inner or right hand cutter is further advanced than the left hand cutter. This is a good feature because the cutters are not on a radial line, hence the inner cutter does cut considerably in advance of the outer cutter, a condition which permits of the use of a head with 14 in. centers equipped with 12 in. cutters to completely cover a surface which by any other method would require that the cutters be interlocked.

The planing of journal boxes in car machine shops is a more or less difficult operation and it seems probable that the Newton ring table type continuous miller would prove valuable in the quantity production of these and similar parts.

Preheating Furnace for Welding Work

The success of welding depends not only on the skill of the welder but also on the manner in which the job is prepared for welding. Experience has taught that metal cannot be welded cold, because as the weld cools it contracts and pulls away from the cold metal in the casting, thus rendering the job useless. Proper preheating is one of the principal factors in reducing welding costs, and it is claimed that the consumption of welding gases can be reduced from 50 to 75 per cent where a good preheating medium is used.



Hauck Preheating Furnace

A practical and satisfactory furnace for preheating, made by the Hauck Manufacturing Company, Brooklyn, N. Y., is shown in the illustration. It consists of a deep box or oven, with a detachable cover, mounted on a preheating table. The box is large enough to accommodate a block of six automobile cylinders and other small parts at the same time. It is equipped with three sliding doors, enabling the operator to watch the work and see that it is not overheated. The inside of the box is lined with asbestos, which retains the heat, and the oven can be used for reheating after welding. The burners can then be turned off and the castings allowed to cool gradually.

By removing the box and cover, the furnace is converted into a preheating table. The combustion chambers, through which the flames of the kerosene preheating burners travel, are lined with a patented type of refractory brick, which breaks the flame up into a number of small, soft, radiating flames. This is an important item in evenly and thoroughly transmitting the heat to the castings or broken machine parts.

The furnace has been found valuable for such work as welding gears, crank-cases, and other parts with comparatively large areas and of intricate formation. The even heating prevents cracking and avoids any possibility of unequal expansion.

Frequently, for unusually heavy, cumbersome parts, the preheating can safely be confined to the break, without heating the entire casting. Loose fire bricks or sheet asbestos are used in this case with one or two of the Hauck preheating burners. The table is then called into service, the part placed thereon and the work started. The burners shown are the so-called hand pump type using vaporized kerosene oil as fuel.

Spiral Tooth Cutter and Grinding Machine

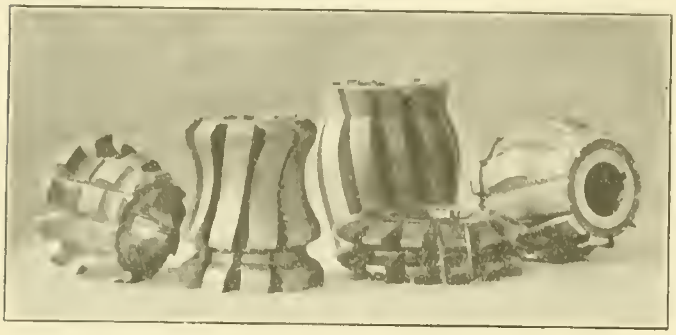
The advantages of spiral cut teeth have long been recognized by users of plain milling cutters. As contrasted with the blow struck by each successive tooth of a straight tooth cutter, the progressive shearing cut with spiral teeth, assures a smooth even surface and permits the use of greater feeds and faster speeds. With these points well in mind, the Pratt & Whitney Company, Hartford, Conn., has developed a formed milling cutter with spiral teeth and eccentric relief to be sold under the trade name of Curvex cutters.

At present, there are in general use two distinct types of cutters for milling contours. The eccentrically relieved formed milling cutters are produced by a broad lathe tool, having a cutting edge of the same contour as the work to be milled. These cutters have the distinct advantage that they can be resharpened by grinding on the face of the tool without changing the form. The contour ground cutter was developed for smoother work and greater freedom in cutting. It is made by gashing the teeth to approximate the desired contour and then finished by grinding each tooth to correspond to a template or former.

Both of the above cutters have straight teeth and consequently are handicapped for production work as the feeds, speeds and depth of cuts have to be restricted in order to produce a smooth surface. It is claimed that Curvex cutters combine all the advantages of the older types of formed cutters, eccentric relief, free cutting qualities and accuracy. In addition to these, they have the advantage of spiral teeth

with the resultant smoothness of cutting and greater feeds and speeds available.

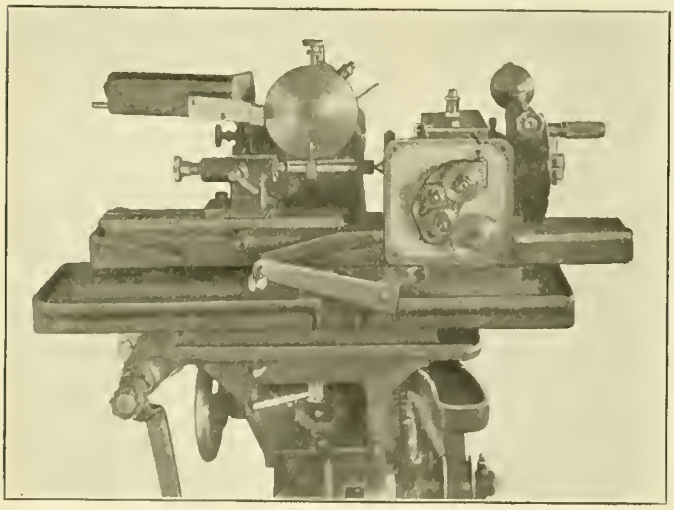
A wide range of sizes is provided and the cutters can be made to order with right or left hand spirals, having practically any lead from 1.607 to 125 in. and with any helix angle up to 20 deg. Due to the fact that no expensive forming tool is necessary these cutters can be manufactured at a slight additional cost over the price of ordinary formed milling cutters.



Curvex Spiral Tooth Milling Cutters

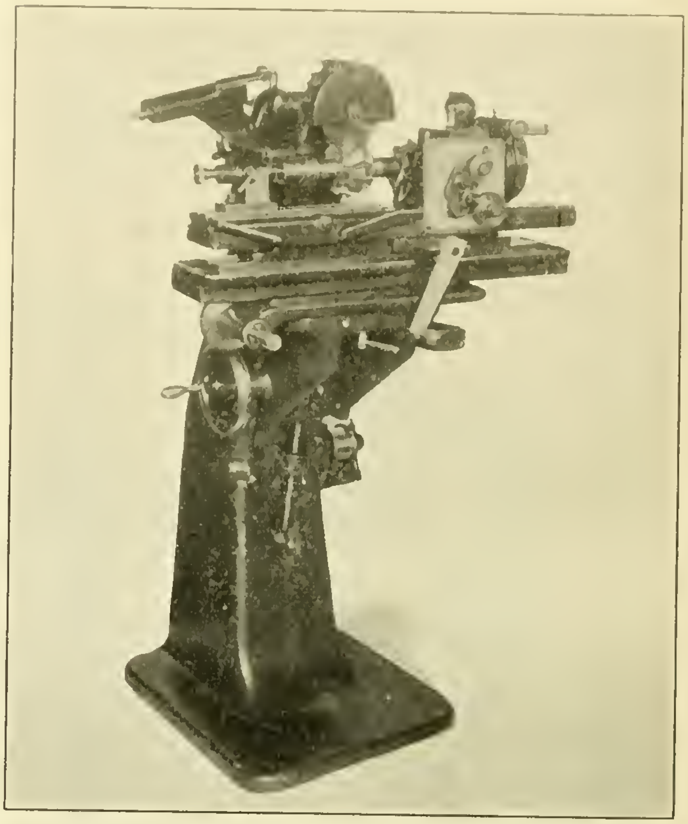
Curvex Cutter Grinder

While designed especially for grinding Curvex cutters, this machine can also be used on all types of milling cutters and hobs with straight cut teeth. It is also adapted for grinding fluted reamers and similar tools. The machine is equipped with a conical grinding wheel which presents but a single line of contact between the wheel and the work at any one time. The wheel may therefore be made to follow accurately the helical path of the tooth and grind the cutting edge to the required form. There is always considerable difficulty in sharpening spiral hobs with a flat face wheel which is inferior to the cone shaped wheel both as regards accuracy and free cutting.



Front View of Cutter Grinder

In grinding the teeth to the required helical path, the machine imparts a combined traverse and rotary movement to the cutter. The table on which the cutter is mounted can be swivelled horizontally about an axis which intersects the axis of the spindle and grinding wheel. When grinding Curvex cutters, the table is swivelled at an angle to correspond to the helix angle of the cutter teeth. It is then reciprocated in the usual way by means of a handle operating a rack and pinion. At the same time a reciprocal rotary movement is imparted to the cutter through a set of change gears selected to conform to the lead of the cutter.



Pratt & Whitney Special Cutter Grinder

An indexing device is provided for successively bringing the teeth in line for grinding instead of holding the back of the tooth against a spring stop. Another interesting feature is the arrangement by which cutters of different sizes can be ground radially without resetting the head or table. The surface of the grinding wheel is kept dressed to the correct shape by means of an accurately mounted diamond. Provision is further made for adjusting this diamond from time to time so as to maintain the true cone angle of the grinding wheel. The machine is arranged for wet grinding which is a feature tending to promote increased production.

Meno Rust Remover and Cleanser

A PREPARATION known as Meno rust remover and cleanser has been developed to remove rust from machines, engines, tools, and all metal surfaces, thereby greatly reducing the time and labor previously required for this work. The compound is a blending of certain chemical ingredients, which in combination produce an electro-chemical action that rapidly loosens and dissolves rust, corrosion, grease, oil, dirt, carbon, paint or any other foreign substance adhering to the metal, irrespective of its age or hardness. It is stated that the action automatically ceases when contact between the cleanser and the metal is established, and it will not injure or mar the surface of the metal itself. One important use of the preparation in railway shops would be in cleaning motion work before repairing it.

The preparation may be applied with a brush or by dipping. It will not burn or explode and protects the metal and

makes it exempt from corrosive or disintegrating action for a long period after treatment. The preparation is an economical one to use, as it does not deteriorate or lose its cleansing power and the same solution may be used many times over. Peter A. Frasse & Company, Inc., New York, are the sole distributors, and are now establishing agencies in various parts of the country for the sale of this preparation.

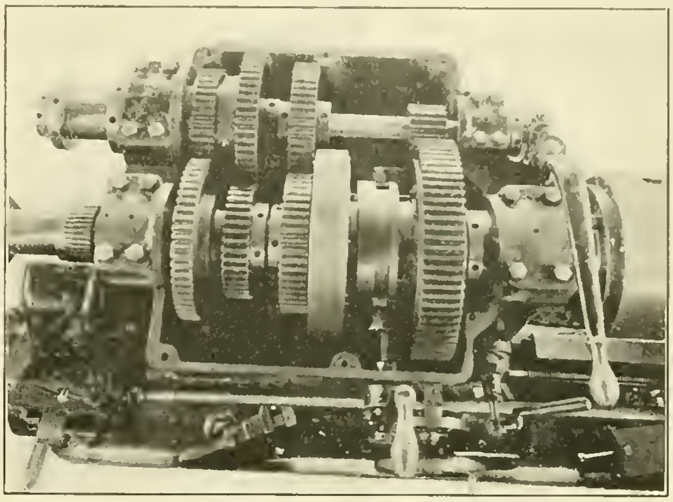
Turret Lathe for Intensive Production

By the elimination of speeds and feeds not actually necessary for the best high speed production practice, it has been possible to simplify greatly the geared head of the turrent lathe illustrated, which is made by the Millholland Machine Company, Indianapolis, Ind. Only foui geared spindle speed changes are furnished, it being maintained that greater production can be obtained where too much reliance is not placed on the operator's judgment as to the speeds and feeds to be used.

Eight broad-face gears and two friction assemblies are provided in the geared head illustrated. A two-step driving pulley is mounted on the back-shaft and provides eight speed changes. But few changes have been made in the friction assembly over other types manufactured by this company. Large driving surfaces are provided with simple adjustments for wear. A bath of oil assures ample lubrication and resultant long life to all moving parts.

Arrangements are made for placing a motor on the headstock cover when individual motor drive is desired. Sight feed lubricators are provided for the main spindle and backshaft bearings. Except for changes in the geared heads, this turret lathe is designed along the same lines as previous models. The tool-post carriage spans the bed, and is arranged to be brought close to the head of the machine, permitting the use of short, sturdy tools. The turret slide and saddle unit is provided with a taper base and taper gibs for horizontal and vertical adjustment. It is operated by a rack and pinion movement, being automatically indexed on the backward movement of the slide.

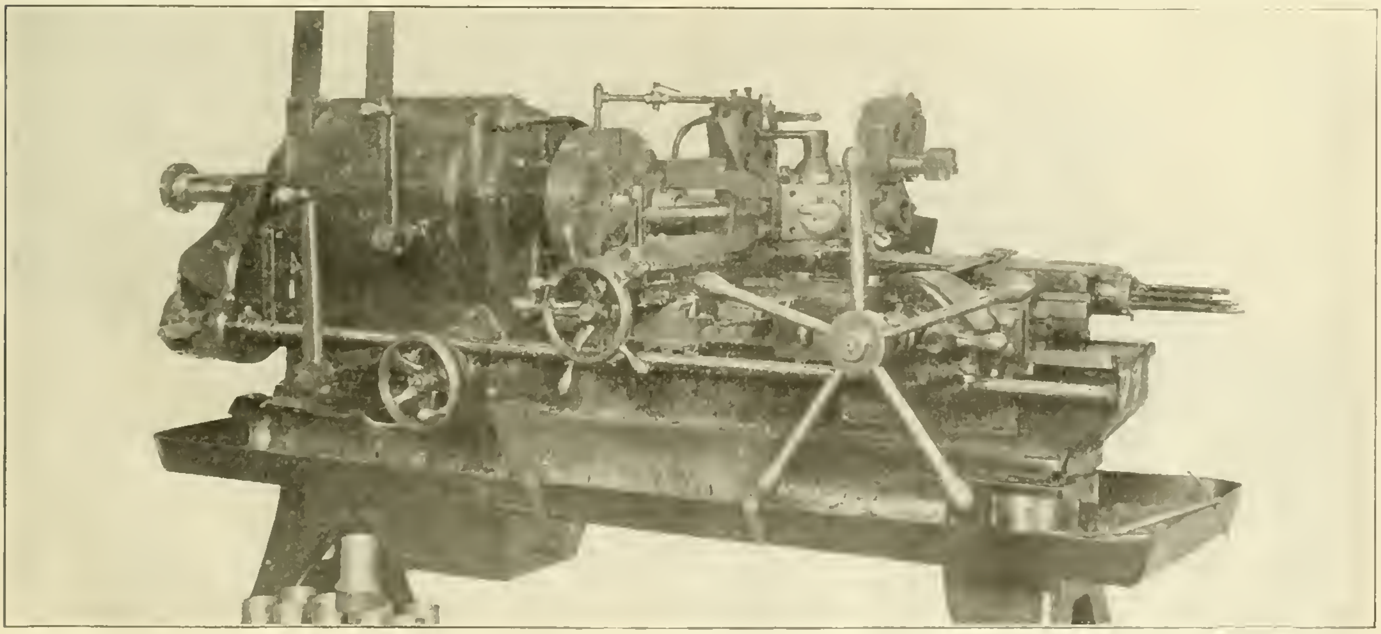
Both the turret and its feed mechanism are interchangeable stops, operating automatically for each position of the turret. Broad bearings are provided for the cut-off slide, which is constructed to insure rigidity under heavy forming and turning cuts. The hand longitudinal feed adjustment is



Gearing Arrangement in Headstock

provided with adjustable clips on a dial so that shoulder positions may be duplicated.

The turret lathe bed is of box section, well ribbed and provided with a pressed steel oil pan and cast iron reservoir



No. 6 Millholland Turret Lathe of 2½-in. Bar Capacity

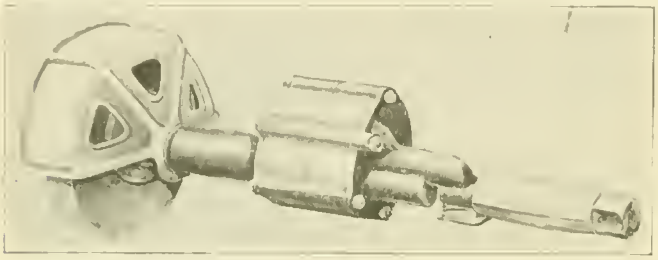
able with that of the corresponding size cone-head machine. Engagement of the turret feed is by means of the lever of the friction clutch, and eight speed changes are available. The feeds are automatically tripped by independent adjust-

underneath. A pump, driven by a pulley on the back gear shaft, furnishes ample cutting lubrication. The new turret lathe is made in three sizes, Nos. 3, 4 and 6, having automatic chuck capacities of 1⅜-in., 1⅝-in. and 2½-in., re-

spectively. The diameters of swing over the turret slide are 6 in., 6¾ in. and 8 in., respectively. The lengths that can be turned are 8 in., 10 in. and 14 in. The respective diameters of swing over bed are 16½ in., 18¾ in. and 21¾ in. Pulleys on the countershafts are recommended to run at speeds of 345, 306 and 283 r.p.m.

Light Weight Portable Pneumatic Grinder

A LIGHT pneumatic grinder, using 6 or 8-in. wheels and weighing 14 lb., has been placed on the market recently by the Roto Pneumatic Company, Cleveland, Ohio. The grinder is simple in both design and construction, there being but three moving parts. The shaft assembly with pistons rigidly mounted constitutes a single rotating member.



Roto Pneumatic Grinding Machine

This, in combination with two self-sealing sliding valves, forms the only moving parts in the motor. By eliminating crank shafts and connecting rods, friction and maintenance costs are greatly reduced. Another advantage is the reduction of motor vibration.

In operation compressed air enters the machine through the control handle and is applied to the pistons in the direction in which the shaft rotates. The turn-handle air control of the motor is self-sealing, absolutely balanced and the throttle will stay in any position in which it is placed by the operator. This control valve will throttle to zero without causing any intermittent pulsation, and when the throttle is closed suddenly, the motor valves automatically release, permitting the air to by-pass and allow the motor to idle down gradually. The air port areas are large and the maximum amount of grinding power can be obtained from the air. Under average conditions about 15 to 20 cu. ft. of free air per min. at 80 lb. pressure are consumed.

The cylinders and valve chest of the motor are of bronze, and bronze bearings are used throughout the machine. The motor bearings are thoroughly lubricated through the center of the shaft from an oil reservoir in the handle of the motor.

Another practical advantage of the machine is the direction of rotation of the grinder, which is such that the sparks and chips are thrown away from the operator and the load of grinding toward him. The machine is adapted for light grinding work around machine shops, such as grinding castings, dressing gas or arc welds, and other miscellaneous grinding work.

Electrical Speed Control for Automatics

MANY advantages in the way of increased flexibility and ease of operation have resulted in the past from the application of electrical speed control to various types of machines. Recognizing this fact, the Cleveland Automatic Machine Company, Cleveland, Ohio, after experimenting for a period of two years, has finally developed an automatically controlled spindle speed-changing mechanism to be applied to Cleveland automatic screw machines. This device is particularly valuable in the case of automatic screw machinery because it is often necessary to rotate the work at different speeds for each successive tool set-up and operation. Various different types of mechanism were experimented with, some of which were automatic and others semi-automatic, or hand operated. The objection to the latter type was that it required one operator for each machine. The machine illustrated is provided with an automatic

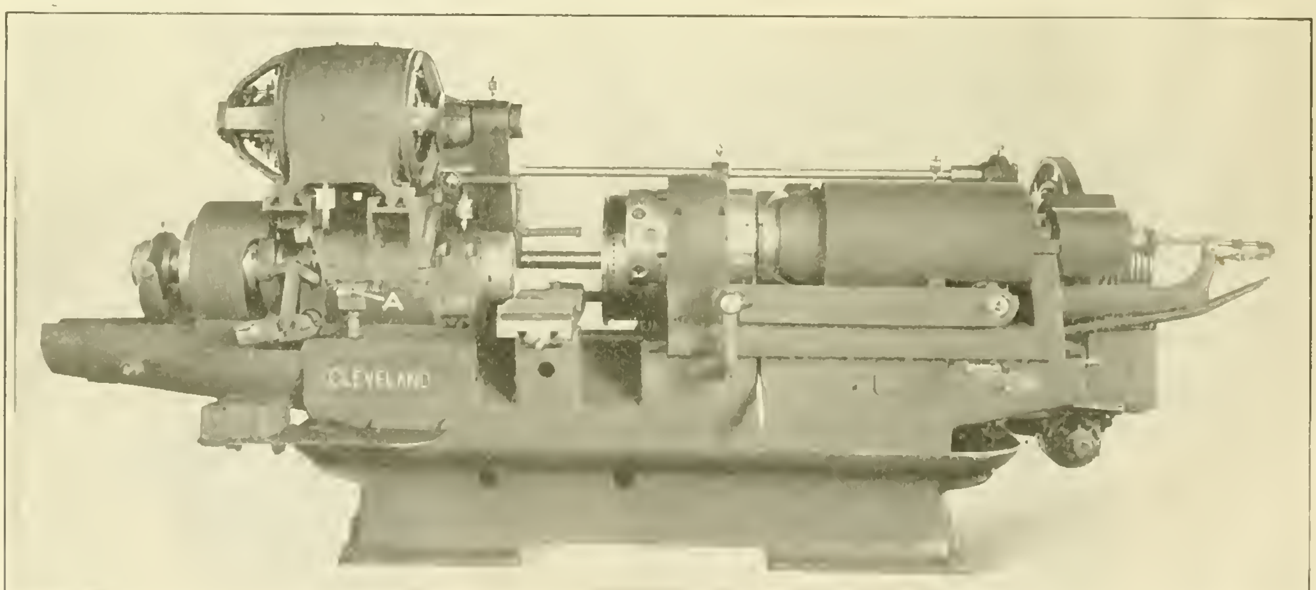


Fig. 1—Large Electrically Controlled Cleveland Automatic Provided With One Driving Motor

mechanism which varies the speed of an adjustable speed-driving motor by regulating the resistance in series with the shunt field windings. It is possible with this mechanism to maintain the correct cutting speed for each tool.

Cleveland automatic screw machines, provided with electrical control, are known as type A automatics. The 1½-in., 2-in., 2½-in., 3-in. and 3½-in. sizes are equipped with two electric motors. One of these is of the adjustable speed reversible type, and is used for driving the spindle only. The other motor runs at constant speed and drives other parts of the machine, including the patented automatic spindle speed controller. The larger, type A automatics, with capacities from 4½ in. to 7¾ in., are provided with only one electric motor. These machines are not furnished with back gears, so that eight changes of spindle speed only are available. Also, because no threading is done on the larger machines, there is no provision for reversing the direction ot spindle rotation. As only one motor is used, the power is transmitted to a shaft running along the hack of the machine to carry movement to all other members of the machine. Sixteen changes of spindle speed are available on the smaller sized machine, giving a range of 10 to 1 in either direction at any point in the cycle.

Method of Obtaining Automatic Control

Front and rear views of the control mechanism are shown in Figs. 2 and 3. Reference to Fig. 1 shows a push button at *A* which controls the starting and stopping of both motors through a main switch. The drum *B* shown in Figs. 2 and 3, is mounted at the end of the main cam shaft. Other cams

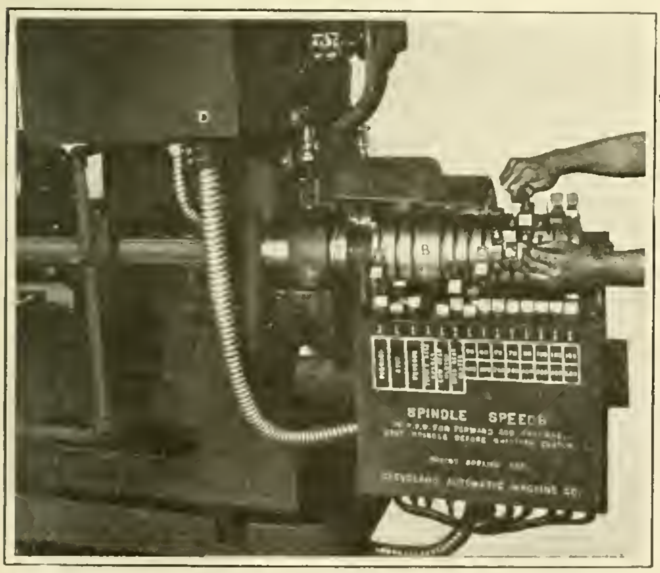


Fig. 2—View Showing Automatic Control Mechanism

on this shaft are so arranged as to properly time all the automatic movements of the machine.

In the smaller sizes of automatics the cam drum *B* is provided with three cams for starting, stopping and reversing the spindle driving motor. Two other cams provide for engaging the high and low speed gears, and the eight cams operate the controller to obtain any of the available speeds. Referring to Fig. 2, the function performed by the several cams, carried on the drum *B*, are plainly marked on the cover plate over the box. In the case of the eight cams that effect speed changes, the speeds that are secured with each cam when the spindle is driven through the high-speed and through the low-speed gears are shown. Each cam engages its respective controller lever at some point in the revolution of the cam shaft. The desired result, in the case of speed changes, is secured when the cams come successively into engagement with respective controller levers when the contactors are carried into engagement with corresponding contacts in the controller box. This results in a variation in field resistance and changes the motor speeds as desired.

The electrical connections are made by a combination rubbing and rolling action that keeps the surface contact clean. Engagement of the high or low speed gears is secured by means of two cams and control levers that operate a solenoid. One complete revolution of the cam shaft and drum *B* means that each cam has performed its function and the finished piece of work has been cut from the bar. A control panel *D* is located at the rear of the spindle-driving

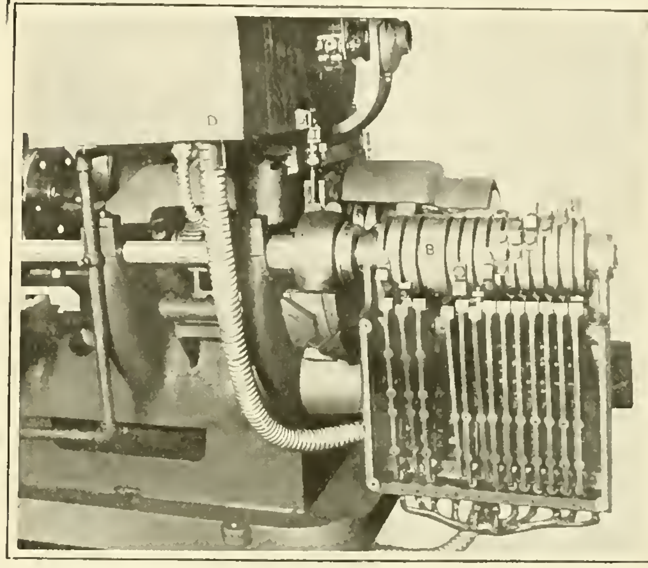
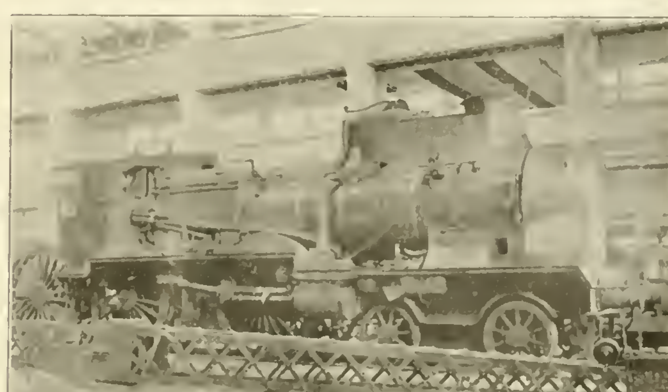


Fig. 3—Automatic Control Mechanism With Cover Plate Removed

motor, and contains the main switch, accelerators and overload coils for both motors. The overload coils are arranged so that an overload on either motor stops the whole machine.

Advantages of Electrical Control

As an example of the flexibility of the Cleveland automatic, due to electrical control, it is maintained that the peripheral speed in a cutting-off operation can be held constant by increasing the speed at which the work is rotated as the tool approaches the center. Maximum production is secured because the cutting speed can be held at the most efficient rate for each operation. Other advantages claimed for this machine are individual motor drive, ease of set-up, and spindle speed changes effected from a standing position as readily as changes in feed.



French Passenger Locomotive in Nevers Shop

Railway Mechanical Engineer

(*Formerly the* RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated*)

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WE GUARANTEE, that of this issue 10,300 copies were printed; that of these 10,300 copies, 9,295 were mailed to regular paid subscribers, 5 were provided for counter and news company sales, 263 were mailed to advertisers, 32 were mailed to employees and correspondents, and 705 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 137,350, an average of 11,446 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Americanization of foreign-born employees, which has been carried on by the Pennsylvania Railroad systematically for several years, has now been extended to the wives of such employees, plans looking to action in this direction having been adopted at a meeting of the Pennsylvania Railroad Women's Club, in Philadelphia. The Pennsylvania Railroad Mutual Aid Society will co-operate in carrying out these plans.

The recent wrecking of an express train outside of Paris, which resulted in the death of nearly 50 persons, and injuries to many more, is causing the French government to consider the need for the adoption of continuous brakes on freight cars. The accident was caused by several cars becoming uncoupled and crashing into the forward section of the train when it was brought to a stop. The damaged cars blocked the track of the express which arrived immediately after.

The Empire State Express, of the New York Central, has now been running 29 years; Tuesday, October 26, having been the anniversary of the first trip. A sketch of the history of the train is given in the New York Central Magazine for October. For many years the train ran through, westbound, New York to Buffalo, 439 miles, in eight hours, with four stops. As patronage increased, necessitating the lengthening of the train to the capacity of the locomotives, the speed was lowered, and the schedule time is now nine hours. In connection with this notice the Magazine denies the rumor, recently printed in various papers, that engine No. 999, which hauled this train on the Mohawk division for a number of years, had been sent to the scrap heap. This engine, William Buchanan's masterpiece, is now numbered 1086, and is still in service, hauling a local passenger train on the Pennsylvania division. It was built in 1893 and cost $13,000. In the last 13 years it has made 13 visits to the shop for general repairs, which repairs cost $14,253.

London's "Safety First" Council

LONDON.

England is making great efforts to stimulate interest in the "Safety First" movement, and has devised an essay competition for children of railway employees. The contest is open to boys and girls under 16 years of age either of whose parents is employed by a railway company and who resides within 20 miles of Charing Cross, London. The papers are to deal with the avoidance of accidents on railways. The prizes offered are: First £3 (approximately $12), second £2 (approximately $8), third £1 (approximately $4), 14 prizes of ten shillings each (approximately $2), and 28 prizes of 5 shillings each (approximately $1).

St. Louis Railway Exposition

A unique and most successful exhibition of railway appliances was held at St. Louis, Mo., October 25-30. It was developed by a group of railroad officers, representatives of employees, railway supply men and influential citizens of St. Louis, to promote educational work along technical lines among railroad employees, and also to develop a spirit of fellowship and comradeship through the several programs.

Southern in Mississippi Changes Name

Official announcement was made last week that the name of the Southern Railway Company in Mississippi has been changed to the Columbus & Greenville Railroad Company. Hereafter the operations of the company will be carried on under the new name, but under the supervision of the same officers as heretofore.

Car Production—Nine Months' Figures

The production of freight and passenger cars for domestic service in September showed an increase over August. The passenger car deliveries were within one car of being as large as those for any two preceding months. The freight car deliveries were the largest for any month since February, although they were still on the low scale that has characterized this year's production to date. The figures, as reported to the Railway Car Manufacturers' Association by the 21 members of that organization and the two non-members co-operating with it in this matter, show deliveries in September of 3,529 freight and 38 passenger cars for domestic service; 1,088 freight cars for export, and freight car repairs amounting to 3,140.

American Railway Association Holds Annual Meeting

The Annual Session of the American Railway Association was held at the Blackstone, Chicago, on Wednesday, November 17, 1920, with R. H Aishton, president of the association, in the chair. Announcement was made that the following were elected members of the board of directors by letter ballot: E. W. Beatty, president, Canadian Pacific; B. F. Bush, president, Missouri Pacific; W. R. Scott, president, Southern Pacific, Texas-Louisiana Lines; A. H. Smith, president, New York Central Lines; W. G. Besler, president and general manager, Central of New Jersey; W. H. Truesdale, president, D. L. & W.; E. J. Pearson, president, N. Y., N. H. & H.; J. H. Hustis, president, Boston & Maine; W. W. Atterbury, vice-president, Pennsylvania System; Daniel Willard,

president, Baltimore & Ohio; Hale Holden, president, Chicago, Burlington & Quincy; W. B. Storey, president, Atchison, Topeka & Santa Fe; H. E. Byram, president, Chicago, Milwaukee & St. Paul; C. H. Markham, president, Illinois Central; C. R. Gray, president, Union Pacific System; N. D. Maher, president, Norfolk & Western; W. L. Mapother, executive vice-president, Louisville & Nashville; H. G. Kelley, president, Grand Trunk.

The Power of Collective Bargaining

The national campaign committee of the sixteen railroad labor organizations addressed a letter to the members of the organizations, outlining instructions as to how to assist in the defeat for re-election of those members of Congress who voted for the transportation act, which contains the following characterization of the law:

"Adroitly phrased by railroad attorneys to achieve that purpose, the Cummins-Esch law destroys collective bargaining by railroad employees through their various crafts, and renders almost valueless protective agencies built up through years of struggle by employers' organizations. This is accomplished in part by the labor sections of the bill and in part by its guaranty provisions.

"The real power behind collective bargaining is the ability and right, when justice warrants, to cause the employer financial loss. Collective bargaining does not function against a guaranteed employer. No employer need fear financial loss occasioned by strikes or vacations of employees if the government or the people are required by law to make up the loss."

The "Best Friend of Charleston"

October marked the ninetieth anniversary of the landing of this historic locomotive in Charleston, S. C., the ship Niagara, bearing the engine from New York, having reached Charleston on October 23, 1830. The Southern Railway Company, in which system the pioneer railroad is now included, commemorates the event by a brief notice in its News Bulletin for September.

The "Best Friend" weighed about four or five tons; or, say, from one-fortieth to one-thirtieth the weight of a Southern Railway express locomotive of today.

The engine was built at the West Point foundry, New York, and the design is credited to Horatio Allen, who ran the Stourbridge Lion, the first locomotive that was ever moved on a track in America. Allen was chief engineer of the South Carolina Canal & Railroad Company. This railroad, extending from Charleston westward to Hamburg, S. C., opposite Augusta, Ga., was the first continuous 10 miles of railway in the world; the second railroad in the United States; the first to run a steam locomotive built in the United States for regular service, and the first in America built with the intention of using steam as motive power.

Metropolitan Section of American Welding Society

The newly formed Metropolitan section of the American Welding Society, at its first meeting on the afternoon of October 25 in the Engineering Societies building, elected the following officers: Chairman, H. A. Currie, assistant electrical engineer, New York Central Railroad; first vice-chairman, E. E. La Schaum, general superintendent motor equipment, American Railway Express Company; second vice-chairman, E. M. T. Rider, chief engineer, Third Avenue Railway Company; treasurer, W. E. Gray, Jr., New York sales manager, Elyria Enameled Products Company; secretary, Howard Odiorne, Submarine Boat Corporation.

Executive Committee

To serve for three years: H. G. Thompson, Transportation Engineering Corporation; William R. Hulbert, Metal & Thermit Corporation; E. J. Kingsbury, United Marine Contracting Corporation; J. C. O'Connell, Federal Shipbuilding Company.

To serve for two years: F. W. Smith, chief engineer, Oxweld Acetylene Company; A. E. Gaynor, J. A. Roebling's Sons Company; Charles H. Haupt, Standard Oil Company; Charles P. Burr, G. M. Meurer Steel Barrel Company.

To serve for one year: R. W. Baker, Lincoln Electric Company; D. Ahldin, Commercial Acetylene Supply Company; M. W. Kellogg, M. W. Kellogg Company; Allen L. Price, Beckley Perforated Company.

Liquidation Staff of the U. S. R. A.

As indicating the extent of the work required to settle up the affairs of the Railroad Administration, which for 26 months had charge of the operation of the railroads, its staff of officers and employees on August 20 included 1,195 persons and its monthly payroll was $250,576. Only a small reduction in force has been made during the period since the railroads were relinquished, although the staff is now only about half as large as it was immediately prior to the return of the roads. On March 1, according to a statement issued by Director General Hines, the force was reduced to 1,223 officers and employees, 1,420 having left the service of the central and regional administrations by March 1. In June, 1919, the total force was 2,725 and the monthly payroll was $575,428. On February 20, 1920, it was 2,612 and the monthly payroll was $570,078.

Shop Construction

Cornwall.—This company has awarded a contract to the Austin Company, Cleveland, Ohio, for the construction of a machine and locomotive erecting shop at Lebanon, Pa. The new building will be of reinforced concrete, brick and steel construction. The dimensions will be 140 ft. by 180 ft. and 50 ft. high. The cost is estimated at approximately $160,000.

Gulf Coast Lines.—This company is constructing temporary buildings at Kingsville, Tex., to replace the machine shops which were destroyed by fire, pending the completion of plans for permanent shop facilities.

Missouri Pacific.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of a power plant at Dupo, Ill., to cost approximately $15,000.

St. Louis-San Francisco.—This company has awarded a contract to the William McDonald Construction Company, St. Louis, Mo., for the construction of a roundhouse and machine shop at Dublin, Tex. The Frisco has also awarded contracts to the Hedges-Weeks Construction Company, Springfield, Mo., for the setting of a new turntable, and the construction of cinder conveyors and materials racks at Dublin. An addition to the car repair shop of this company at Fort Scott, Kan., is being built by the T. S. Leake Construction Company, Chicago, at a cost of about $15,000.

Southern.—This company is building a brass foundry at its Lenoir Car Works, Lenoir City, Tenn., which will cost approximately $30,000. The building will be one story, 62 ft. by 120 ft., of brick and concrete construction. This addition to the plant will involve the purchase of five revolving furnaces, a metal separator and a journal bearing boring machine.

Southern Pacific.—This company will construct the following buildings at Sacramento, Cal.: A reinforced concrete oil and paint house, 65 ft. by 100 ft.; a store building of mill construction with corrugated iron sides, and concrete foundation, 500 ft. long and 60 ft. wide, and a planing mill of mill construction, with corrugated iron sides and roof, to be 126 ft. wide and 360 ft. long.

Reduction of Forces

Reductions of railroad forces by the dismissal of considerable numbers of men on short notice, particularly in shops, has been reported recently from many places. The Pennsylvania Railroad, in dismissing 1,350 men at the Altoona shops, about 15 per cent of the total force, giving the men five days' notice, announced that this was to be deemed a permanent reduction in force, not a temporary lay-off. This move was made necessary by a reduction in the volume of repair work and affected all departments except the iron and brass foundries. About 1,500 employees were dismissed from shops on the Central Pennsylvania division of the road and 1,000 on the Philadelphia division. The New York Central dismissed 500 men at West Albany, four-fifths of these being shop men. The Boston & Albany has dismissed about ten

per cent of the forces in its principal shops. The New York, New Haven & Hartford has dismissed considerable numbers of men in various departments. Certain shops of the Baltimore & Ohio report dismissals of ten per cent of the employees.

Recent Locomotive Orders

National Railways of Mexico.—Florian & Co., Ltd., importers and exporters, 52 Wall street, New York, confirm the report that they have closed a contract with the Mexican government for the delivery of $20,000,000 of railroad equipment and material. The negotiations were completed in Mexico City and the contract is signed by the Minister of Railways and the National Railways of Mexico. The contract calls for the delivery of locomotives, cars and material for section houses. Certain credits have been extended to Mexico in this connection which are properly secured; all financial arrangements in connection with this contract have been completed. Florian & Co., Ltd., further confirm the report that the purchase of the equipment will be made through their New York office.

Freight Car Orders

The National Railways of Mexico has ordered 100 tank cars of 12,000 gallons capacity from the American Car & Foundry Company.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V.—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411 C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting December 14. Paper on The Every Day Duties of a Roadmaster will be presented by E. Keough, assistant engineer of maintenance of way, Canadian Pacific Railway, Montreal. Illustrated by stereopticon views.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meetings second Thursday in January, March, May, September and November, Iroquois Hotel, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November, Hotel Sinton, Cincinnati, Ohio.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 23 to 26, 1921, inclusive, Planters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting December 14. Paper on Some Phases of Railway Operations in Canada will be presented by Grant Hall, vice-president, Canadian Pacific Railway Company.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Second annual dinner, Hotel Commodore, New York, Thursday, December 16, at 6:30 p. m.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Regular meetings January, March, May, September and October.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Meetings second Friday in month except June, July and August. Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, Chicago. Meetings third Monday in month except June, July and August.

PERSONAL MENTION

GENERAL

C. E. Bingham has been appointed supervisor of mechanical examinations of the Michigan Central, with headquarters at Detroit, Mich.

J. Herron has been appointed acting superintendent of motive power of the Duluth, South Shore & Atlantic, with headquarters at Marquette, Mich., succeeding J. J. Conolly, granted leave of absence.

Charles A. Nelson, formerly senior mechanical engineer, Bureau of Valuation, Interstate Commerce Commission, has returned to the mechanical engineer's office of the Delaware & Hudson at Watervliet, N. Y.

D. M. Pearsall, superintendent of motive power of the Atlantic Coast Line, second and third divisions, with headquarters at Waycross, Ga., has been transferred as superintendent of motive power, first division, with headquarters at Rocky Mount, N. C. J. E. Brogdon, shop superintendent at Waycross, Ga., has been appointed superintendent of motive power, second and third divisions, with the same headquarters, succeeding Mr. Pearsall. F. P. Howell, master mechanic at Savannah, Ga., has succeeded Mr. Brogdon as shop superintendent at Waycross, and J. W. Reams has been appointed master mechanic at Savannah, succeeding Mr. Howell.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Edward France has been appointed road foreman of locomotives of the Mohawk division of the New York Central with headquarters in Rensselaer, N. Y.

S. J. Kelley has been appointed master mechanic of the Erie, with headquarters at Hornell, N. Y. This appointment is the result of the division of the territory of C. H. Norton, who remains master mechanic of the Susquehanna and Tioga divisions, but relinquishes the Allegheny and Bradford divisions to Mr. Kelley.

C. J. Quantic, master mechanic of the Canadian National at Port Mann, B. C., has been transferred to Vancouver and given jurisdiction over all lines west of and not including Edmonton, Alta. A. H. Mahan, district master mechanic of the Grand Trunk Pacific at Edson, Alta, has been appointed assistant master mechanic of the Canadian National and the Grand Trunk Pacific, with the same headquarters. Mr. Mahan will have jurisdiction over the lines from Edmonton, Alta., to McBride, B. C., and from Edson, Alta., to Mountain Park, Alta. A. Walts, district master mechanic of the Grand Trunk Pacific, with headquarters at Smithers, B. C., has been appointed assistant master mechanic of the Canadian National and the Grand Trunk Pacific, with the same headquarters. His jurisdiction will include all lines from McBride, B. C., to Prince Rupert.

CAR DEPARTMENT

A. H. Eager has been appointed general superintendent of rolling stock on the Canadian National and Grand Trunk Pacific, with headquarters at Winnipeg, Man. Mr. Eager was born on July 15, 1868, at Waterloo, Que., and entered railroad service in June, 1885, as a machinist apprentice in the shops of the South-eastern, at Farnham, Que. After a short time he left the service of this road to enter the shops of the Canadian Pacific, at Farnham, and was made a machinist in 1893. After serving as machinist for six years, he was made locomotive shop foreman and served in this capacity until 1901, when he was promoted to locomotive foreman, at Megantic, Que. In 1903, he was transferred to Cranbrook, B. C., where he was employed until May, 1906, when he was promoted to general foreman, with headquarters at Calgary, Alta. From 1907 to 1910, Mr. Eager served successively as district master mechanic, with headquarters at Kenora, Ont., and as locomotive foreman at Calgary, Alta. In 1910, he entered the service of the Canadian National, as superintendent of shops, with headquarters at Winnipeg, Man., a position which he held until August, 1916, when he was promoted to assistant superintendent

of rolling stock of the Western lines of the Canadian National. At the time of his recent appointment, Mr. Eager was mechanical superintendent of the Canadian National, with headquarters at Winnipeg, a position to which he had been promoted in December, 1918. The office of mechanical superintendent has been abolished.

SHOP AND ENGINEHOUSE

C. W. ADAMS, general foreman of locomotives on the Michigan Central, with headquarters at St. Thomas, Ont., has been promoted to superintendent of shops, with jurisdiction over the locomotive department, and with headquarters at Jackson, Mich., succeeding W. C. Bell, who has been transferred to Bay City, Mich.

P. J. FLYNN, general roundhouse foreman of the Erie at Hornell, N. Y., has accepted a position in the Lehigh Valley shops at Pittston, Pa., as general foreman.

I. W. HICOK, erecting shop foreman on the Chicago & Alton, with headquarters at Bloomington, Ill., has been promoted to superintendent of shops, with the same headquarters, succeeding J. J. Carey. William Monroe succeeds Mr. Hicok.

PURCHASING AND STOREKEEPING

B. B. BRAIN, fuel agent of the Kansas City Southern, with headquarters at Kansas City, Mo., has been appointed purchasing agent, succeeding G. W. Bichlmeir, resigned to accept service with another company.

F. S. HAMMOND, general storekeeper of the Pittsburgh, Shawmut & Northern, has been appointed purchasing agent in addition to his other duties.

G. H. WALDER, assistant purchasing agent of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been promoted to purchasing agent, succeeding W. A. Linn, who has been assigned to other duties.

OBITUARY

C. C. HIGGINS, superintendent of motive power of the St. Louis-San Francisco, was killed at Racine, Mo., the night of November 3, when a freight train crushed into his private car. Mr. Higgins was born at Aurora, Ill. He graduated from the mechanical engineering department of the University of Minnesota in 1900, and immediately entered railroad work as a special apprentice in the service of the Chicago, Burlington & Quincy. After five years with that road, during which he served successively as assistant in the laboratory, roundhouse foreman and general roundhouse foreman at various points on the line, he left to become associated with the American Brake Shoe & Foundry Co., in its Chicago office. During the next four years he served as sales engineer and salesman with this company. In 1909, however, he returned to railroad service, accepting an appointment with the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., where he was assigned to special work in connection with the motor schedules of the mechanical department. In 1912 he was engaged by J. W. Kendrick, consulting railway engineer, Chicago, to make reports on various railroads in connection with the valuation and rehabilitation of their properties. When the position of assistant to the vice-president of the St. Louis-San Francisco was created on March 15, 1918, Mr. Higgins was appointed to that position. He was made superintendent of motive power on March 1, 1920, the position he held at the time of his death.


C. C. Higgins

SUPPLY TRADE NOTES

F. M. Whyte, vice-president, with office at New York, of the Hutchins Car Roofing Company, Detroit, Mich., has resigned.

The Colburn Machine Tool Company has removed its entire business from Franklin, Pa., to its new plant at 1038 Ivanhoe road, Cleveland, Ohio.

W. A. Ruth, who recently resigned from the sales force of the National Car Coupler Company, has become affiliated with the Superior Steel Castings Company, Benton Harbor, Mich.

G. Schrimer has resigned as sales engineer in the Detroit office of the Whiting Foundry Equipment Company, Whiting, Ill., and is now associated with W. C. Bennett, industrial engineer, Chicago.

Albert E. Newton, vice-president and general manager of the Reed-Prentice Company, has resigned. He will, however, remain with the Reed-Prentice Company in an advisory and consulting capacity until 1922.

D. J. Crowley has been appointed Michigan sales agent of the Tacony Steel Company, Philadelphia, Pa. Mr. Crowley's office is in the Dime Bank building, Detroit, Mich. D. B. Carson has been appointed Cleveland district sales manager.

G. E. Anderson, assistant eastern sales manager of the Duff Manufacturing Company, Pittsburgh, has been promoted to southwestern sales manager and placed in charge of the new branch office located in the Railway Exchange Building, St. Louis, Mo.

Joseph Markham, formerly railway sales representative of the E. I. Du Pont de Nemours & Co., Inc., has been appointed sales agent of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with an office in the Peoples Gas building, Chicago.

W. H. DeWolfe recently has been appointed district manager of the New Britain Machine Co., with headquarters at Room 638, Old South building, 294 Washington street, Boston. Mr. DeWolfe formerly was connected with the Philadelphia office of this company.

The Blaw-Knox Company, Pittsburgh, Pa., has established a new sales district in the South, with headquarters at Birmingham, Ala. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of this office, which is located in the American Trust building.

C. F. Meyer, assistant secretary of the Landis Machine Company, Waynesboro, Pa., will leave shortly for an extended trip to the Orient in the interests of his company. Mr. Meyer will visit England, India, the Dutch East Indies, Australia, the Philippine Islands, China, Japan and the Hawaiian Islands.

Anton Becker, assistant to president of the Ralston Steel Car Company, Columbus, Ohio, has been elected vice-president to succeed F. E. Symons, who has been elected president. The other officers of the company are F. A. Livingston, secretary and treasurer, and L. C. Roy, assistant secretary and assistant treasurer.

Frederick T. Davis, formerly with the Davidson Tool & Manufacturing Corporation, is now connected with the New York branch office of the Reed-Prentice Company, the Becker Milling Machine Company and the Whitcomb-Blaisdell Machine Tool Company, located at Grand Central Palace, New York city.

The Chicago Pneumatic Tool Company announces the removal of its rock drill plant from 864 East Seventy-second street, Cleveland, Ohio, to its Boyer pneumatic hammer plant at 1301 Second boulevard, Detroit, Mich. The company's Little Giant air drill plant still remains at 1241 East Forty-ninth street, Cleveland.

R. G. Barrington, formerly connected with the Cleveland Twist Drill Company, Cleveland, Ohio, has been appointed Cleveland sales manager for the Reed-Prentice Company, the Becker Milling Company and the Whitcomb-Blaisdell Machine Tool Company, with headquarters at 408 Frankfort avenue, Cleveland, Ohio.

L. R. Fedler has been appointed district manager for the Keller Pneumatic Tool Company in the Milwaukee district, with offices at 915 Majestic building, Milwaukee. For the past twelve years, Mr. Fedler has been associated with the sales organization of the Chicago Pneumatic Tool Company in the Milwaukee territory.

The Howard N. Potts medal, which is awarded for distinguished work in science and mechanical arts by the Franklin Institute, was presented on October 20 to E. P. Bullard, Jr., president of the Bullard Machine Tool Co., Bridgeport, Conn., for his work in connection with the development of automatic machinery in the metal-cutting field.

A new policy of direct selling for all three companies has been established, under the charge and control of John P. Ilsley, formerly general manager of the Becker Milling Machine Company's plant. Branch sales offices have been established in the leading cities of the United States and a foreign sales manager has been employed for Europe.

Alfred J. Babcock, president of Manning, Maxwell & Moore, Inc., New York, who retired in May, 1920, on account of ill-health, died on October 30, in London, England, after a short illness. He was born at Brookfield, N. Y., in 1850, and served in the United States Army from 1867 to 1871. He took a law course at Ann Arbor, and practiced law in Denver, Colo., from 1882 to 1884. Mr. Babcock entered the machinery business in Chicago with the Fay & Egan Company and later entered the employ of Manning, Maxwell & Moore, Inc., at Chicago, as manager of that branch. About seven years ago he came to New York as assistant to president, and later was made president. He retired from active service in May, 1920, on account of continued ill health.

A. J. Babcock

The name of the selling organization which C. C. Bradford recently formed, has been changed from the Manufacturers' Sales Company, to the Bradford Sales Company. The offices of this company, which will represent not more than two manufacturers as a district sales office of each, are located at 340 Leader-News building, Cleveland, Ohio.

C. E. Hildreth has offered to resign as president of the Whitcomb-Blaisdell Machine Tool Company, in view of the consolidation in management. He has been requested, however, to allow the situation to remain in statu quo, which he has consented to do, pending the working out of the plan for centralizing the management of the different plants.

Steps have been taken to centralize the production and manufacturing departments, and F. O. Hoagland, until recently vice-president and general manager of the Bilton Machine Tool Company, Bridgeport, Conn., has taken the position of general manager of the Reed-Prentice Company, the Becker Milling Machine Company and the Whitcomb-Blaisdell Machine Tool Company.

A. H. Tuechter, president of the Cincinnati-Bickford Tool Company, Oakley, Cincinnati, Ohio, was elected president of the National Machine Tool Builders' Association, at its annual meeting at the Hotel Astor, New York. Mr. Tuechter has served that organization as second vice-president, and at one time was a member of the joint general committee of the American Society of Mechanical Engineers.

Under the name of Midgley & Borrowdale, a partnership, with headquarters in the McCormick building, Chicago, has been formed by S. W. Midgley and J. M. Borrowdale, both of whom were formerly connected with the Liberty Steel Products Company, to deal in railway supplies. A contract has already been closed with the Superior Steel Castings Company, Benton Harbor, Mich., manufacturers of steel and malleable iron castings, for the exclusive railway sales of the company's products, and the partners are also western sales representatives of the Pneumatic Safety Valve Company, Woonsocket, R. I., manufacturers of safety air valves for pneumatic tools; the Henry Giessel Company, Chicago, manufacturers of sanitary filters and water coolers for passenger cars and locomotives, and the Trumbull Waste Company, Philadelphia, Pa.

S. W. Midgley

S. W. Midgley entered railroad service in 1898, in the office of the Car Mileage Bureau. In 1902, he entered the railway supply business as general sales representative of the National Car Coupler Company, remaining with this company until late in 1907. He then became connected with the Curtain Supply Company as western sales representative, later becoming western sales manager. In 1911 he left the Curtain Supply Company to enter the service of the Acme Supply Company as general sales manager, remaining in the service of this company until January 1, 1918. He then became district manager of the Chicago office of the Liberty Steel Products Company and remained with that company until the closing of its Chicago office, September 30, 1920.

J. M. Borrowdale began railroad service in 1890, with the Fitchburg Railroad, at Boston, Mass. In 1893 he came to Chicago to enter the employ of the Chicago, New York & Boston Refrigerator Company as a car builder. He remained with this company until 1896, when he left to enter the Burnside shops of the Illinois Central. Here he served successively as a car buider, foreman, and general foreman, until 1909, when he was appointed superintendent of the car department of that road. In 1917, he left railway service to join the sales force of the H. W. Johns-Manville Company, and two years later went with the Liberty Steel Products Company, with which company he remained until the Chicago office was closed, September 30, 1920.

J. M. Borrowdale

E. P. Williams, formerly with McJunkin Advertising Agency, and later director of field work, Bureau of Market Analysis, Inc., has joined the staff of the Independent Pneumatic Tool Company, manufacturers of Thor air and electric tools. Mr. Williams will be located in Chicago.

The Reed-Prentice Company, the Becker Milling Machine Company and the Whitcomb-Blaidsell Machine Tool Company, which are largely owned and controlled by the same interests, have decided, for the purpose of efficiency, to consolidate still further the operating management of all three plants, with the result that a centralized executive office has been established at 53 Franklin street, Boston, Mass., under the direction of Arthur H. Weed, president.

The Graver Corporation, East Chicago, Ind., manufacturers of steel tanks and general plate construction, oil refinery equipment, water softening and purifying equipment, announces the opening of branch offices in the following cities: New York, 280 Broadway; Pittsburgh, Pa., 62 Conestoga building; Kansas City, Mo., 1001 Gloyd building; Cincinnati, Ohio, 220 Gwynne building; Toledo, Ohio, 314 Nicholas building, and San Francisco, Cal., 312 Balboa building.

Donald S. Barrows, chief engineer and works manager of The T. H. Symington Company, New York, since 1917, with headquarters at Rochester, N. Y., has been elected vice-president in charge of operations. He was born at New Haven, Conn., in 1877, and graduated from the New York Law School in 1898 and was admitted to the bar in New York State in 1899. Following his entry into the engineering field and previous to his association with the Symington organization Mr. Barrows held the following positions: Chief engineer of the North Penn Iron Company, Philadelphia, Pa.; chief engineer of the Insley Iron Works, Indianapolis., Ind.; mechanical engineer of the Wonham-Magor Car & Manufacturing Company, and mechanical engineer with the American Car & Foundry Company, at New York. Mr. Barrows entered the service of The T. H. Symington Company in 1915, and as chief engineer had charge of all engineering matters in conection with the Symington railway products as well as the planning, enlargement and execution of extensive plant improvements. In 1917 he was promoted from the position of chief engineer to chief engineer and works manager, and now becomes vice-president in charge of operations. In the development of the Symington company's extensive railway business at Rochester to its present state of efficiency in quality and quantity production Mr. Barrows has been largely responsible.

D. S. Barrows

Fairbanks, Morse & Co., Chicago, have bought the entire business consisting of all stock on hand, good-will and liabilities of the Luster Machine Shop & Railway Equipment Company, 917 Arch street, Philadelphia, Pa. Fairbanks-Morse have opened a new branch at this address under the management of D. W. Dunn, and will sell its complete line of engines, motors, pumps, etc. The entire personnel of the Luster Machinery Co. has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

L. C. Wilson, for the past two years general sales manager of the Chain Belt Company, Milwaukee, Wis., has been elected secretary of the Federal Malleable Company, West Allis, Wis., manufacturers of malleable castings, malleable chain and the Rapid molding machine. Mr. Wilson, after graduating from Yale University, began his business career as a salesman with Harbison-Walker Refractories Company, Pittsburgh. In 1917 he became associated with the Chain Belt Company and served as assistant to the vice-president until his appointment as sales manager. Clifford F. Messinger, who is also a graduate of Yale University, and has been with the Chain Belt Company since 1909 in various capacities, including that of advertising manager, manager of Rex concrete mixer sales and assistant to the vice-president, has been appointed sales manager of the Chain Belt Company, to succeed Mr. Wilson.

The Morse Chain Company, Ithaca, N. Y., has established a branch factory in Detroit which will be devoted exclusively to the manufacture of silent chain sprockets and the Morse adjustment for use in automobile power transmissions. The manufacture of chains and power transmission at the main plant at Ithaca will continue. The Detroit branch will be under the general management of F. C. Thompson, with F. M. Hawley as chief engineer, and C. B. Mitchell as factory manager. The sales and engineering offices are located at the Detroit plant, Eighth and Abbott streets.

Arthur E. Hauck, president of the Hauck Manufacturing Company, makers of oil burning appliances, kerosene torches, furnaces and forges, Brooklyn, N. Y., died at his home in that city on October 30, at the age of 41. He was born in Germany, where he learned the trade of coppersmith. At the age of 20 he came to America and in 1902 began business in Brooklyn. He was the inventor of a number of appliances for burning oil, one of which was the method of vaporizing kerosene in a torch with proportioned heat-resisting nozzle, the form of vaporization which is used to reduce carbonization to a minimum.

The J. B. Engineering Sales Company, 60 Prospect street, Hartford, Conn., has been appointed Connecticut sales agent of the Conveyors Corporation of America, formerly the American Steam Conveyor Corporation. The J. B. Engineering Sales Company is owned by John Breslau, who is a graduate of the Sheffield Scientific School, Yale University, and was formerly sales engineer, manager of publicity and production manager of the Terry Steam Turbine Company. The J. B. Engineering Sales Company is sales agent also for the Griscom Russell Company and the Terry Steam Turbine Company, in Connecticut.

J. B. Webb has been appointed western representative of the Diamond Specialty & Supply Company, Philadelphia, Pa. Mr. Webb has, for many years, been manager of the railway supply department of the Simmons Hardware Company, and in that capacity handled the products of the Diamond Specialty & Supply Company, including water gage glasses, lubricator glasses, Watertown automatic cylinder cocks, Steinbrunn boring bars and other devices. Through this new arrangement he will sell these goods to the railroads operating out of Chicago and west of the Mississippi river. Mr. Webb's headquarters are at 713 Chestnut street, St. Louis, Mo.

John A. Talty, assistant superintendent of equipment and equipment inspector for the New York Public Service Commission, Second district, has taken a position as special engineer with the Franklin Railway Supply Company, New York. Mr. Talty began railway work in 1883 as freight brakeman on the Erie Railroad. He consecutively served as foreman and locomotive engineman on that road and then as air brake instructor on the Westinghouse air brake instruction car on the Erie. Later he took a similar position with the Scranton Correspondence School. From 1900 to 1910 he served as road foreman of engines on the Delaware, Lackawanna & Western. In the latter year he joined the force of the public service commission as assistant supervisor of equipment and equipment inspector, inspecting locomotives and cars and investigating accidents, and he now leaves that position to go to the Franklin Railway Supply Company.

The Landis Machine Company, Waynesboro, Pa., has just completed a new addition to its shop, which will be the main machine shop. This new building is 308 ft. long by 146 ft. wide. Nearly 365 tons of steel were used in the construction, which was under the direction of A. R. Warner. The building is modern in every respect, being provided with the best of heating and lighting arrangements. A five-ton crane with a span of 66 ft. operates the entire length of the building and will provide means for moving heavy castings. On October 30 the company gave a house warming party in the new shop to Landis employees and their families. Approximately 1,400 guests attended and enjoyed the

good things arranged for them. Addresses were made by J. C. Benedict, general manager, and S. F. Newman, assistant general manager of the Landis Machine Company. The party was concluded in the evening by a special entertainment, after which the employees presented to the management a set of resolutions expressing thanks and appreciation for the good time afforded and opportunity for closer fellowship.

F. Hopper has resigned as division master mechanic of the Chicago, Milwaukee & St. Paul to accept a position with the Standard Stoker Company, Inc., as works superintendent at Erie, Pa. Mr. Hopper has been in constant railway service since 1893. He served his apprenticeship as machinist at the old W. T. Garratt Machine Company, San Francisco, Cal., and from 1889 to 1890 was in the marine service of the Pacific Mail Steamship Company. He then went to China as a mechanic. Later he became a mechanic and locomotive foreman on the Guatemala Central. He then entered the service of the Edison Light Company, Napa City, Cal., as an electrician and chief engineer. From 1893 to 1897, he served as a fireman on the Southern Pacific, when he was promoted to locomotive engineer. Resigning this position, he entered the employ of the Chicago, Rock Island & Pacific as road foreman of equipment. In 1911 he was promoted to master mechanic; in 1913 resigned to accept a position as master mechanic on the D. W. & P. Railway, which is controlled and owned by the Canadian Northern, and in 1919 entered the employ of the Chicago, Milwaukee & St. Paul.

S. T. Callaway, of the firm of Callaway, Fish & Co., New York, and his associates have acquired a substantial interest in and are financing the Elvin Mechanical Stoker Company, and Mr. Callaway has been elected president of the company. A. G. Elvin, the inventor of the Elvin mechanical stoker, who is largely interested in the company, has been elected vice-president and treasurer. Mr. Elvin is also the inventor of the Elvin driving box lubricator, the Franklin grate shaker and the Franklin fire door, and other successful economy producing devices in the steam locomotive specialty field. S. T. Whitaker, of the law firm of Hardy, Stancliffe & Whitaker, attorneys for the company, has been elected secretary. The directorate of the company includes the officers as mentioned above, and E. M. Richardson, of the Sherwin-Williams Company. A long term contract has been entered into with the American Locomotive Company, under which the stoker will be manufactured for this company by the American Locomotive Company, at its Schenectady works, thereby enabling the company to accept immediately contracts in quantity for stokers.

Hugh Pattison has joined the staff of the heavy traction railway department of the Westinghouse Electric & Manufacturing Company to make special engineering studies under the direction of F. H. Shepard, director of heavy traction. Mr. Pattison was graduated from the Johns Hopkins University, electrical engineering course, in 1892. His first position was that of foreman electrician of the Norfolk, Va., Navy Yards, wiring and installing electric apparatus on naval vessels. In 1893 he became assistant engineer with Sprague, Duncan & Hutchinson, consulting engineers at Baltimore. From 1894 to 1903 he was associated as engineering assistant to Frank J. Sprague, vice-president and technical director of the Sprague Electric Company in New York and assisted in equipping and operating multiple unit control on the Boston Elevated and in Brooklyn. In 1905 Mr. Pattison joined Westinghouse, Church, Kerr & Company as an engineer. From 1905 to 1911, during the electrification of the Pennsylvania tunnel into New York, Mr. Pattison was assistant engineer of electric traction for George Gibbs, consulting engineer. Later Mr. Pattison had charge of the electrification of the West Jersey & Seashore Railroad from Camden to Atlantic City. He also built an experimental single-phase electric railway on the Long Island Railroad and had charge of the conduct of locomotive tests on the West Jersey & Seashore Railroad to determine the effect on track. In 1911 he was appointed engineer in charge of the Chicago Association of Commerce Committee in the study of smoke abatement and the electrification of terminal railways in Chicago. During the war Mr. Pattison was appointed assistant to general manager of the Remington Arms Company.

The Precision & Thread Grinder Manufacturing Company, manufacturers of the multi-graduated precision grinder, have moved their offices to 1 South Twenty-first street, Philadelphia, Pa. At this new location they will maintain a machinery display department, showing in addition to their grinders, the Craley master tool maker, Miller radius and angle wheel dressers for tool room and production work, the Herrmann snap thread gages, and other tools and accessories.

TRADE PUBLICATIONS

Locomotives.—The general dimensions and illustrations of various types of eight-coupled locomotives for freight service and locomotives for heavy passenger service are given in two illustrated books, Records No. 98 and 99, issued by the Baldwin Locomotive Works, Philadelphia, Pa.

Ajax Metal Products.—A new 38-page, illustrated export catalogue has been issued in two editions—one English, and one Spanish—by the Ajax Metal Company, Philadelphia. This book is mainly devoted to a complete listing of Ajax products, with a detailed account of their uses in the various industries.

Foundry Equipment.—In Bulletin No. 154, issued by the Whiting Foundry Equipment Company, Harvey, Ill., are described and illustrated complete layouts and equipment for gray iron, steel, brass, car wheel and malleable iron foundries. The bulletin contains a large number of illustrations taken in Whiting equipped plants.

Wood Preservation.—Two folders recently issued by the Barrett Company give information regarding the preservation of timber by the use of refined creosote. One entitled "Preserving Wood Roof Decks with Carbosota" describes the surface treatments recommended for lumber used in roof construction. The second, entitled "Longer Life for Mine Timbers," discusses the selection and treatment of timber, not only for mine bracing but also for cars and buildings subject to decay.

Malleable Castings.—The American Malleable Castings Association has published a chart which is designed to show the present status of the malleable iron industry. The chart gives a graphical representation of the castings shipped by the member firms as compared with the capacity of the foundries. The association points out that it is expected that the tonnage of unfilled orders will be reduced in the near future and better deliveries will be made than have been possible since 1915.

Portable Electric Drills.—The complete line of electric air compressors, portable electric drills and electric valve grinders made by the Black & Decker Manufacturing Company, Baltimore, Md., is described in Catalogue No. 2, recently issued by this company. The booklet includes descriptions of compressors of various capacities, electric drills for drilling holes up to 7/8 in. and reaming up to 7/16 in. in steel. The mechanical and electrical features of the equipment are quite fully described and the construction is shown by sectional views.

Fire Brick Bond.—"Hytempite in the Gas Plant" is the title of a bulletin issued recently by the Quigley Furnace Specialties Company, New York. According to the bulletin, Hytempite is a highly refractory plastic material, scientifically compounded, for bonding fire bricks and for kindred uses. The importance of this bond in the construction and maintenance of gas producers is particularly emphasized in the bulletin, but it can be used in railway shop or other industrial furnaces and boiler settings. Illustrations of this fire brick bond in emergency repairs are shown.

Pipe Valves, Fittings and Tools.—An attractive and unusual catalogue is the book recently published by the Walworth Manufacturing Company, Boston, Mass., for its export business. The extensive line of fittings, valves, boiler and engine accessories, and tools which this company produces is illustrated, descriptions being given in English, French, Spanish and Portuguese. Valuable engineering information is included such as the amount of expansion cared for by bends in wrought iron or steel pipe and conversion tables for English, metric and Latin units, etc. A comprehensive index in each of the four languages facilitates locating the equipment listed.